Life cycle behavior under uncertainty
Essays on savings, mortgages and health

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Abstract

Households must take into account various sources of uncertainty when making financial decisions. In the aftermath of the financial crisis of 2007-2008 some of these uncertainties have increased and, arguably, households may have become more aware of the uncertainties they encounter. The purpose of this thesis is to examine to what extent different sources of uncertainty influence household financial decision making, in particular regarding saving, portfolio choice and the choice of financial products such as mortgages.

We show that uncertainty related to the outcome of future policies (i.e. limiting the mortgage interest deduction), induce households to save more than optimal to absorb possible financial setbacks. We further demonstrate that financially less sophisticated households, who do not fully understand the complex nature of mortgage loans, tend to choose less risky mortgages, unless they consult a mortgage broker.

Using detailed tax records, we provide evidence that elderly households are on average wealthy, but do not dissave. This contrasts with the prediction of the life-cycle theory of saving and cannot be explained by uncertainty regarding income or out-of-pocket medical expenses. Health plays an important role in explaining differences in wealth between households.

Using self-reported health combined with objective health measures from medical records, we show that health is more persistent and deteriorates at a faster rate in old age than can be inferred from subjective health measures alone. We further show that mental ill-health combined with an unhealthy lifestyle (smoking and being overweight) is a major contributor to long-term sickness among self-employed (with income insurance).

Abstract (in Dutch)

De financiële crisis van 2007-2008 maakt duidelijk dat onzekerheid er toe doet. De sterke daling in aandelen- en huizenprijzen, in combinatie met riskante hypotheekleningen, heeft een grote invloed op de financiële positie van huishoudens. Het doel van dit proefschrift is te achterhalen in welke mate onzekerheid het financiële keuzegedrag van huishoudens beïnvloedt, zoals het spaargedrag en de aanschaf van financiële producten zoals een hypotheek.

Wij laten zien dat de onzekerheid omtrent toekomstig beleid met betrekking tot een hervorming van de hypotheekrenteaftrek ervoor zorgt dat huishoudens meer gaan sparen om mogelijke financiële tegenvallers op te vangen. Wij tonen vervolgens aan dat huishoudens die minder kennis hebben van hypotheekleningen, geneigd zijn om een minder riskante hypotheeklening af te sluiten, tenzij zij gebruik maken van een

tussenpersoon.

Uit een analyse van gedetailleerde belastinggegevens blijkt dat ouderen gemiddeld gezien vermogend zijn, maar hun spaargeld nauwelijks aanspreken, zelfs niet op een zeer hoge leeftijd. Deze bevinding is in tegenspraak met de economische levenscyclustheorie en kan niet worden verklaard door onzekerheid over toekomstige inkomsten of gezondheidsuitgaven. De gezondheidstoestand speelt wel een belangrijke rol om verschillen in besparingen tussen huishoudens te verklaren.

Op basis van door mensen zelf ervaren gezondheidstoestand en objectieve gezondheidskenmerken uit medische registers laten wij zien dat gezondheid meer persistent is en sneller afneemt op oudere leeftijd dan kan worden geconcludeerd op basis van enkel gerapporteerde gezondheid. Tot slot tonen wij aan dat in het bijzonder mentale gezondheidsproblemen in combinatie met een ongezonde levensstijl (roken en overgewicht) het risico op langdurige arbeidsongeschiktheid onder zelfstandigen vergroot.

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For me, this journey started in the summer of 2008 as an intern at the CPB Netherlands Bureau for Economic Policy analysis. It was the summer that the financial crisis spread to Europe from the United States. As a student interested in Economic Policy, this was an exciting time. It enabled me to experience at first hand the efforts by colleagues to advise the government how to recover from the economic crisis. Most of all, this was a great way to figure out what it means to do policy relevant research. I am very grateful to Mauro Mastrogiacomo for his enthusiasm and encouragement. Part of the research in this thesis is the outcome of the lengthy discussions we had at that time. It has been delightful to collaborate and spend time with you over the past years. I would also like to thank Casper van Ewijk for providing me this opportunity and his encouragement to apply for a PhD position.

Starting a PhD in Groningen has been a great experience. I could not have wished for better supervisors. In my mind Rob Alessie is the ideal PhD supervisor. In addition to being an expert in the area of saving behavior and applied econometrics, he is always willing to discuss problems and provides support whenever necessary. I enjoyed the numerous conversations and "Rail lectures" in the train on Thursday evenings with a cup of coffee after diner at "De Boom". Adriaan Kalwij is very thoughtful and precise, he pointed at many important things I could not have figured out myself. It was always great to discuss new research ideas. I hope to collaborate on many more research projects with the both of you.

I finished this thesis while visiting University College London. I could not have asked for a better place to expand my experience. Mariacristina De Nardi is both a wonderful person and host. My scientific interest for saving behavior is greatly inspired by her paper asking the question: "Why do the elderly save?" I came across this paper while I was preparing for my PhD application interview. Intrigued by the paper, I mentioned that I was very enthusiastic to start working on this topic for the Netherlands. Rob Alessie revealed that he had a very similar idea. That is where it started. Now, four years later, I feel very privileged to actually work on a structural model under your guidance and that you are part of the reading committee.

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Raun van Ooijen
Groningen, September 2015

Contents

Chapter 1

Introduction

1.1 Motivation and research questions

Households must take into account various sources of uncertainty when making financial decisions. In the aftermath of the financial crisis of 2007-2008 some of these uncertainties have increased and, arguably, households may have become more aware of some of the uncertainties they encounter.

First, there is "policy uncertainty" about the reforms policymakers my implement in the future and the outcomes of already implemented reforms of the pension system, labor market, health care sector and mortgage market. The aim of these reforms is to foster economic growth, to reduce the government budget deficit, and to keep the social insurance system sustainable in view of an aging society. However, it is unclear how such reforms will affect households' financial situation and how policy uncertainty influences economic decisions made by households.

Second, reforms of the social insurance system mainly result in a shift of publicly funded social insurance to more individual responsibility. For instance, households become more in charge of their pension savings and should make more provisions for long-term care for themselves, in case they are no longer able to live independently. This means that households have to take uncertainty of the return of their portfolio, life expectancy and health more into account than in the past when making financial decisions.

Third, the financial crisis, which followed a relatively stable economic period, makes clear that financial decisions can have a huge impact on the financial situation of households. Many households have underestimated the uncertainty of the return of their financial portfolio and did not consider rare events, like a large drop in house prices. This exemplifies that households may not be perfectly informed or aware of all financial

risks.

The empirical literature to date normally regards uncertainty as a general concept relating to lack of knowledge about future outcomes and has been rather silent on how these three different sources of uncertainty influence household financial decision making. The purpose of this thesis is to examine to what extent different sources of uncertainty influence household financial decision making and how this affects economic behavior, in particularly regarding saving, portfolio choice and the choice of financial products such as mortgages. The central questions of this thesis are as follows:

Does uncertainty, related to the outcome of future policy, result in precautionary saving?
Do households who do not fully understand the complex nature and the risk profile of some financial products choose alternative, but simpler substitutes?
Does financial advice result in better outcomes?
Does a reduction in pension benefits and limitations in the provision of public long-term care increase precautionary savings?
What is the likelihood of a deterioration in health at different stages in life and how persistent is this health shock?
How do health shocks relate with socio-economic variables?
What are the influences of both mental health, physical health and healthy lifestyle on the ability to work?

When households make financial decisions they have to consider changing circumstances during their life, such as retirement, having children, or a deterioration of health. They also have to consider changing economic conditions, such as the level of income, prices, and asset returns. How these changes affect household economic behavior over time was first described in an economic model developed by Modigliani and Brumberg (1954). The simple version of the life cycle theory assumes that all changes in life are known by household in advance. It predicts how households allocate their consumption and saving over time to make them equally well-off in every period of life.

In reality, as motivated above, future circumstances are very uncertain. Households have to form expectations about future input variables, such as health status and income when making financial decisions. As time goes by, more information about these input variables becomes available, households may have to reconsider their original plans. In every period households have to choose their optimal allocations given their available information and economic resources.

Financial decision making under uncertainty is not only very complex for households but also difficult to formally solve in an economic model. The important role of uncer-

tainty to understand household behavior was recognized by Modigliani and Brumberg when they developed the life cycle theory. At that time, the importance of uncertainty was already extensively discussed by John Maynard Keynes (1936). In the *General theory of employment, interest and money*, Keynes stresses that uncertainty is one of the major motives to put money aside to self-insure against future contingencies. Over the last two decades uncertainty has been incorporated in life cycle models and now plays an important role in explaining economic behavior as has been emphasized in the work by Deaton (1992) on consumption and saving.

The first paper of the thesis, chapter two, describes the role of policy uncertainty to explain household financial behavior. Chapter three focus on financial uncertainty, which might be amplified for households who do not fully understand the complex nature and the risk profile of some financial products. Chapter four discusses in what manner uncertainty affects motives for saving and how this relates to observed wealth decumulation and portfolio choice of elderly households. Chapter five measure health related uncertainty over the life cycle and relates this to socio-economic variables. Finally, chapter six takes the multidimensional concept of health into account; it examines the role of physical ill-health, mental ill-health and healthy lifestyle on disability among self-employed workers. The remainder of this introductory chapter first describes the main findings of the thesis. Then, it provides policy recommendations. Finally, directions for future research are given.

1.2 Summary and main findings

In chapter two of the thesis we analyze whether uncertainty, related to the outcome of future policies, results in precautionary saving. The focus is on an important example of policy uncertainty: the possible limitation of the mortgage interest deduction (MID) in the Netherlands. To measure policy uncertainty, we sent out dedicated questionnaires to the CentERpanel – a panel comprising more than 2,000 Dutch households that complete weekly Internet-based household surveys – at strategic moments in time of the reform process. We elicited the subjective distribution of house prices in both a "policy neutral" scenario without a reform of the MID and a realistic, but simplified hypothetical reform scenario. We examined whether households that are more uncertain about the influence of this particular reform on house prices also tend to save more, as economic theory would suggest.

We find that households recognize both aggregate house price uncertainty and policy uncertainty. There is no clear evidence that households which are more uncertain about aggregate house price movements save more than households that are less certain. We do find that policy uncertainty alone increases precautionary saving. Policy uncertainty

accounts for approximately two percent of total saving. The main message of our study is more general: reforms must be credible and clear enough to limit distortive second order effects, such as those caused by policy uncertainty.

The third chapter analyzes whether households who do not fully understand the complex nature and the risk profile of some financial products select alternative but simpler products. Moreover, it examines the effectiveness of financial advice. The chapter focuses on mortgage loan choice which is one of the largest financial decisions that most households make. It is commonly known that a large group of households lack basic financial knowledge and do not possess the financial skills to take complex decisions, such as selecting a mortgage loan (see Campbell, 2006). A limited understanding of mortgage contracts and the risks involved may have contributed to the origination of the 2007-2008 financial crisis (see Gerardi et al., 2013b).

To this end, we designed a special questionnaire for the CentERpanel. Our survey was set up to collect information on mortgage risks, debt literacy and the role of financial advice in selecting a mortgage. Our results demonstrate that homeowners appear to be well aware of mortgage risks. Large loans relative to home value are perceived as more risky, as are loans with large mortgage payments relative to income and loans linked to investment vehicles. Homeowners with riskier mortgages indicated that they could encounter financial problems should house prices or their income decline. Homeowners with relatively low debt literacy are more likely to take out traditional mortgages with principal repayments over the maturity of the loan. Riskier mortgages are more prevalent among homeowners with a better understanding of loan contracts. Financially less sophisticated homeowners consulting mortgage brokers, too, hold more risky mortgages.

The fourth chapter analyzes saving behavior and portfolio choice after retirement in the Netherlands where uncertainty related to health expenditures and pensions used to be limited. The generous pension system and almost complete coverage of the public health and long-term care insurance system makes precautionary saving less necessary compared to, for instance, the United States. Using detailed administrative data, we present evidence on the extent to which the financial resources of retirees are affected by shocks such as the decease of a spouse or deteriorating health, similar to recent empirical studies by Poterba et al. (2011, 2012, 2014) for the United States. Moreover, we examine the extent to which retirees who do not experience any shocks are able to keep positive wealth at their disposal and sustain their consumption level during retirement.

Our results show that the death of a spouse results in a significant reduction of household wealth. This result is also found in the United States. We do not find evidence of decumulation of wealth after retirement for singles, despite the fact that retirees face limited income uncertainty and limited uncertainty about out-of-pocket

payments for medical expenses. Although, we find some suggestive evidence of dissaving for high-income widowed persons. Moreover, we find no evidence of dissaving in the years before death, even among those in poor health who have a lower life expectancy. This contrasts with the prediction of the life-cycle theory by Yaari (1965) and Hurd (1989) for singles without a bequest motive. Possible explanations are that: (1) generous pension benefits are protective of household wealth, (2) most assets are stored in illiquid housing wealth which constrains the decumulation of wealth, (3) bequests and transfers of wealth after the death of the first spouse are important and provide a motive for holding assets. Finally, the results suggest that health plays an important role in explaining differences in wealth between households. On average, retirees with health problems have accumulated lower pensions and private savings. Moreover, we find evidence that the onset of a serious health problem result in an increase in wealth holdings, probably because of lower consumption needs in poor health.

To further analyze the association between health and savings, it is important to measure health-related uncertainty at different phases in life. In chapter five we construct a health measurement model which combines panel survey data on self-reported health with a rich set of health measures from administrative medical records. Our estimated health model allows us to predict health status for the entire population. We account both for unobserved heterogeneity and for the persistence in unobserved health shocks. To account for inconsistent reporting in self-reported health over time we propose a 'corrected' health measure. We show that this 'corrected' measure substantially increases the estimated persistence in health status. We use predicted health status to study the evolution of health as individuals get older. Moreover, we analyze how health interacts with education and economic variables.

The results show that there are significant disparities in health by gender and across groups with different levels of educational attainment. The age at which health starts to decline at a greater rate differs by educational level and gender. Women are on average in worse health than men. Moreover, women have more health advantages from higher education than men. The results also suggest that economic variables as income and wealth are more protective for women's health than for men's health. A possible explanation is that poor health is in particular detrimental for household income when this affects the earning capacity of the main earner. In the Netherlands, women have a high labor force participation rate, but predominantly work part-time.

The previous chapter suggests that the ability to work may have important implications for the financial situation of the household. In chapter six we analyze the interdependence between initial mental health, physical health and lifestyle on the entry into and exit out of disability. The lifestyle habits that we consider are smoking, drinking and doing sports. We also consider overweight which is linked to lifestyle

habits such as physical inactivity and poor diet. We use a Dutch insurer's portfolio of income insurance contracts of self-employed workers and construct measures of physical and mental health on the basis of current and previously diagnosed health problems as reported upon buying income insurance.

Our results show that physical ill-health, mental ill-health and bad lifestyle habits generally have adverse effects on the inflow into disability and outflow back into employment of self-employed workers with income insurance. Mental ill-health is the major cause of long-term disability. The results also stress that accurate assessment of the relation between health, lifestyle and disability outcomes requires a subgroup analysis that distinguishes several groups of policyholders, such as smokers versus non-smokers and overweight versus normal weight. The subgroup analysis is crucial because important differences between subgroups tend to vanish in an aggregate analysis. The subgroup analysis shows that the risk of becoming disabled is exacerbated by unhealthy lifestyle, such as being overweight and smoking. In particular, the combination of smoking and being overweight has a large adverse effect on the recovery from disability. The results of our study can contribute to more effective criteria for risk selection and medical underwriting, the development of risk-based insurance premiums for income insurance, prevention of disability among self-employed and optimization of their return-to-work process.

1.3 Policy proposals

The above results are relevant for public policies that facilitate household financial decision making under uncertainty. In this section we will consider policy proposals which follow from the analysis.

Safeguard independent financial advice

Given the complex nature of mortgage loan decisions, many households seek the help of a mortgage broker or other financial intermediaries who match borrowers and lenders in the mortgage market and provide financial advice to households. Our results show that homeowners who consult advisers have more risky mortgages, regardless of their level of literacy (high or low). Nevertheless, the impact of advisers on the riskiness of the mortgage loan is less pronounced for the more literate consumers. We are not able to address the issue of causality, given that those homeowners planning to take out a more risky mortgage may have been the ones seeking advice from an adviser. However, the results highlight the importance of independent financial advice and a commission structure without incentives to advise risky mortgages when they are less suitable.

That is why several countries have changed the legal rules for fee structures in the financial advice market. In the Netherlands, for instance, commission fee payments to intermediaries for the origination of mortgages have been banned since January 2013. Consumers now have to pay the adviser directly for all services. This type of commission structure reduces concerns about mortgage advisers having incentives to give advice that goes against the interest of the consumer; see also Inderst and Ottaviani (2012) for a discussion about how effective a ban on commission fees is when it comes to selecting financial products.

This may result in more conservative mortgages being recommended and taken out, and, thus, fewer households with financial problems. On the other hand, high brokerage fees may discourage homeowners from obtaining financial advice. Although it is not clear beforehand whether homeowners will display the same behavior in the new setting, it is somewhat comforting that the results suggest that consumers with low literacy levels who do not consult financial advisers tend to take out less complex and more conservative mortgages.

As a remedy, policymakers may consider making financial advice mandatory for unsophisticated households or for households who plan to take out a risky mortgage product. The Authority for the Financial Markets (AFM) in the Netherlands has, for example, developed a test to assess household's financial capability to take out a mortgage without financial advice. A few mortgage lenders made a similar test mandatory for households who prefer to originate a mortgage without help. Although, overall, this would be helpful in reducing mortgage risks to homeowners, it would put a burden on those homeowners who are capable of taking a mortgage decision on their own.

Implement credible reforms

Despite the fact that the Dutch government implemented a reform of the mortgage interest deduction, the majority of households expect new or additional reforms. This suggests that the implemented reforms were not felt as being definitive and create additional uncertainty. We show that policy uncertainty related to a possible reform of the mortgage interest deduction could depress consumption. The government could reduce policy uncertainty by implementing credible policy, i.e. policies that could induce consumers to believe that the future policy environment will by and large remain unchanged.

Eligibility for public long-term care insurance should not depend on wealth

People who find it important to save for long-term care (LTC) are discouraged from doing so if the eligibility for public LTC depends on the level of wealth. There is strong empirical evidence that the introduction of asset-testing – which requires persons to first run down their assets in order to become eligible for public LTC – discourages saving, particularly if the quality of publicly provided LTC is high.

A means-tested system that is based only on the level of income does not have these disadvantages. In order to restrict the utilization of public-provided care it is more efficient to increase income-related payments. A benchmark study about LTC expenses among OECD countries shows that income-related payments are relatively low in the Netherlands (OECD 2011). This is in particular applicable for care at home. When a household is unable to pay these higher income-related expenses, for example because all savings are in illiquid housing wealth, they can be deferred until after death. At that time, claims can be recovered from the estate before the estate is transferred to the heirs.

Facilitate the use of housing assets for long-term care

Housing equity is rarely spent throughout old-age and is commonly left as a bequest. Housing equity is a very suitable means to save for LTC because the elderly do not downsize their housing equity except in the event of severe illness or after the decease of the spouse. This implies that housing equity becomes available in situations when health and LTC expenditures are potentially large. We show that for the vast majority of homeowners who permanently stay in a nursing home, the proceeds from the sale of the house can cover a nursing-home stay of more than five years. Housing equity is therefore a valuable vehicle to save for LTC services that will not be covered by the public LTC insurance system.

The government can encourage the accumulation of housing equity by allowing individuals to use part of their pension savings to pay off mortgage debt or by discouraging home equity borrowing before retirement. A lower mortgage debt also reduces the costs of living because of lower mortgage payments. This provides more scope to cover immediate costs from financial assets without the need to sell the house. In addition, the government can discourage transfers to the children after the decease of the spouse. Our analysis suggests that these transfers are currently substantial.

Develop financial products combining reverse mortgages and long-term care

Housing equity is essentially not available for LTC expenses unless a person sells the house and moves elsewhere. Financial products to extract home equity such as reverse mortgages are therefore beneficial if a person desires care at home or if only one of the household members moves to a nursing home. The market for these type of products is thin, partly because of the relative high costs of compensating the lender for the large risk that the total amount of monthly payments exceeds the value of the house. This could either happen because the last surviving borrower remains in the home for a long period or because house prices decline.

A reverse mortgage product providing a line of credit that can only be used for LTC expenses reduces this risk, for two reasons. First, persons in need of LTC are already at an advanced age and typically remain in their home for a relatively short period. Second, given that the line of credit can only be used for LTC-related expenses, there is a lower risk that all home equity will be spent. This is also beneficial for people who like to leave a bequest.

Align pension benefits with consumption needs in old-age

In the current pension system, pension income does not decrease with age. This does not reflect the declining needs as people age, such as food consumption, spending on cloths, durable goods and leisure activities. Our analysis provides evidence that the marginal utility of consumption declines in old-age because of deteriorating health. This results in higher savings in old-age due to the comprehensive coverage of health care expenditures. It is questionable whether people take this declining consumption path into account while planning for retirement. Besides, they are not able to borrow against future pension benefits to increase consumption at the start of retirement. To align pension benefits with actual consumption needs, policy makers may consider a pension system with a payout that declines with age.

If desired, the required funds can be provided for LTC services that will not be covered by the public LTC insurance system, such as residing in a nursing home with better care facilities or more intensive home care that makes it possible to stay at home for a longer period.

Integrate pensions and long-term care

Our analysis shows that a sizable fraction of the Dutch elderly has accumulated a small buffer of financial wealth that is sufficient for small incidental expenditures but

insufficient for large expenditures such as LTC. This predominantly holds for renters and not for homeowners. The introduction of individual saving accounts for LTC is inefficient since they demand excessive wealth accumulation to self-insure against potentially large LTC expenses. Moreover, it is doubtful whether these accounts generate additional savings by people with a low income who have little room for saving.

One attractive alternative is to require persons at retirement to make an active choice between a lower (age-declining) pension that provides additional payments when persons are in need of LTC and a 'normal' pension that provides a constant stream of pension benefits. The exact additional payments will depend on the severity of the disability, which is determined by an assessment of needs. The problem of adverse selection in this product is limited for two reasons. First of all, persons who are in need of LTC have a lower life expectancy and consequently a lower expected present discounted value of future pension benefits. Second, persons have to commit themselves for one of both products already at the start of retirement when the prevalence of LTC is low. Asymmetric information about future LTC use is also limited at an earlier age. An additional benefit of combining LTC and pensions is that it leads to a reduction in costs. For an extensive welfare analysis of a combination of LTC and annuities, see Murtaugh et al. (2001).

Another possibility is to use the funds released due to lower pensions to pay for the premiums of an LTC policy, which covers the costs of LTC on top of the basic public LTC. However, the experience from the United States and the United Kingdom shows that the willingness to buy these insurance products is very low.

1.4 Avenues for future research

For future research, we plan to develop life cycle models to interpret the empirical facts as provided in this thesis. Dynan et al. (2002) explain in great detail that it is difficult to disentangle different saving motives using household wealth alone. The theoretical insights from this model are, therefore, crucial to interpret the empirical facts on the evolution of wealth and income over age. For instance, it not obvious why elderly households in the Netherlands keep large amounts of housing wealth at very advanced ages. It is not self-evident that they use this as a buffer against uncertain and large medical expenses at the end of life.

One promising direction is to extend the basic life cycle model with housing choice. The issue of household consumption smoothing and portfolio choice in the presence of illiquid housing wealth is extensively discussed in chapter four of this thesis. High adjustment costs of housing equity possibly constrain the evolution of retirement wealth. The strategic bequest motive might provide an alternative explanation why the elderly

do not reduce housing equity in old age as it provides a motive for commitment. Holding home equity as opposed to annuity wealth may increase the parents' bargaining power in the event of illness and old age (see Bernheim, Shleifer and Summers, 1985). This might lead to different conclusions about the adequacy of retirement savings and the relative importance of uncertainty for wealth accumulation. In addition, the extended life cycle model must be able to explain the "puzzling" pattern between health and wealth after retirement. We plan to thoroughly model the health dependency of consumption and the possible interaction of wealth and health with the bequest motive.

The theoretical insights from the extended life cycle model and the empirical results from chapter four of the thesis will be integrated in a structural model for the Netherlands to explain the saving behavior of the elderly. Such a model makes it possible to quantitatively analyze the importance of various proposed but not yet implemented policy reforms of the pension system and of the long term care system on the saving behavior and well-being of retirees. We will take the extended life cycle model of De Nardi et al. (2010) as starting point of analysis. Their model allows for (i) an altruistic bequest motive, (ii) differential mortality (e.g. the observation that richer people live longer) and (iii) uncertain medical expenses. Moreover, the model of De Nardi et al. (2010) takes into account that the marginal utility of consumption depends on the health status of the individual. This implies that deteriorating health affects the level of consumption and therefore affects wealth holdings.

The health measurement model, which we have developed and described in chapter four of the thesis, will be used to measure health-related uncertainty at different phases in life. In chapter six we have showed that physical ill-health, mental ill-health and health related lifestyle habits have different effects on the ability to work. Moreover, it seems that these different "dimensions of health" exacerbate each other. In future research we plan to take the multidimensional concept of health into account. We will examine how different health shocks could have very different effects on longevity, labor supply, and savings.

In chapter four we have also analyzed the evolution of wealth and income over age of elderly households to obtain insight into their financial position. For a better understanding of whether their retirement savings are adequate it is also important to have more insight into their spending patterns. The spending pattern of elderly households changes over time because of changing needs when people retire (see Kalwij et al., 2015; Soede, 2012). Spending may also change in the period after retirement when changes such as widowhood or the onset of health problems may influence both the necessary and preferred level of expenditures. A relevant question is with what kind of necessary expenses elderly are confronted. For example, expenses directly related to a person's health status or expenses on services and equipment to help elderly stay living at home.

In recent years, the Dutch government has implemented reforms of the long-term care insurance system. The aim of these reforms is to stimulate elderly with minor disabilities to stay living independently. The reform limits admissions to nursing home care to persons with major disabilities. In addition, people are expected to pay a larger part of the costs of a nursing home stay from their income and savings. A means test which is based on the level of wealth has also been introduced. Municipalities and health insurers have become responsible for the provision of care and support at home for which less public resources will be available. People with minor care needs are expected to first ask for informal care from their spouse or relatives before municipalities will arrange the necessary care. These reforms thus imply a shift away from publicly provided long-term care to private providers, as well as more individual responsibility.

It is unclear how these reforms affect the financial position of the elderly and whether this results in disparities in the provision of long-term care between municipalities and for elderly with different financial means. Moreover, the introduction of a means test may discourage saving and encourage inter vivos transfers as currently private nursing home costs depend on the level of wealth.

In future research we plan to shed more light on these issues. More specifically, we will gain more insight into the composition of health-related expenses of elderly households, such as an adaption of the home or moving to a more suitable accommodation, buying equipment such as a stairlift, and paying for care and support at home. There is very limited insight in the private expenditures on long-term care and how sensitive these expenditures are for the price that people have to pay for these expenses. Moreover, we do not know how the demand for non-health consumption changes when health deteriorates and how this affects their savings: people will probably spend less on leisure activities but spend more on food and transport if they are no longer able to prepare their own meals or to drive a car. When preferences for spending on ordinary consumption decline in poor health it allows households to pay a larger share of long-term care expenses out of pocket.

Acquiring insights into the preference for health-related expenses of elderly households, on the one hand, allows policy makers to adjust the long-term care insurance system to better reflect personal preferences regarding health related expenditures. For example, to give patients a greater role in the choice between residing in a nursing home or more intensive home care that makes it possible to stay at home for a longer period, and to allow them to choose the location and quality of a nursing home, the preferred level of services and the amount of care. In addition, it allows policy makers to assess the adequate level of basic care needs which they have to provide without the risk of excessive health payments among the elderly which might result in poverty. Finally, it allows them to assess how much additional, or “luxury care”, individuals are willing

to pay out of pocket. This could relieve some of the burden of the public funding of long-term care.

A related question is whether there is demand for financial products to cover "luxury care", such as an annuity that pays a lump sum that varies with the level of needs or a reverse mortgage product providing a line of credit that can only be used for LTC expenses. As described above, the experience from the United States and the United Kingdom is that the market for these products is almost non-existent. More insight into the willingness to buy these insurance products is relevant for the development of these financial products which facilitate the private provision of LTC.

The demand for these products not only depends on the patient's needs and preferences for "luxury care", but also on the availability of informal care, preferences for non-health consumption in poor health and personality traits such as the level of risk aversion. In addition, there is a trade-off between spending on "luxury care" and the amount of money left to give to the children. Persons with a bequest motive may prefer to spend less on long-term care. To examine these questions one could use a questionnaire for acquiring information on health expenditures and preferences. The information on individual preferences obtained from a questionnaire can also be used to identify the relative importance of different motives for saving in a structural life cycle model, as it is not possible to derive these motives using data about saving and consumption alone. We believe that combining administrative records on wealth and survey data on individual preferences for saving will be a very promising direction to contribute to the long lasting debate on the determinants of wealth accumulation.

Chapter 2

Policy uncertainty and precautionary saving

2.1 Introduction

In most of the Western world, house prices have been falling since the onset of the 2007–2008 financial crisis, especially in countries with a very elastic housing supply (as in Spain) and in countries where both the housing and mortgage markets are highly regulated and households are highly indebted (as in the Netherlands and Denmark, where households own a disproportionately large mortgage portfolio).[1] In response to the financial crisis, policy makers are proposing (or have already implemented) reforms of the mortgage and housing market to prevent future crises. These proposed reforms, aim to limit excessive mortgage lending, and will likely affect future house prices.[2]

The 2007-2008 financial crisis thus makes clear that households—and also financial institutions that have residential mortgage-backed securities on the balance sheet—face considerable house price risk. Housing equity is often the most important asset in the financial portfolio for most households and can be an important source of retirement savings. Therefore, house price risk may have an important impact on current saving decisions and the portfolio allocation by households.

The theory of precautionary saving predicts that the decision to save not only depends on future income risk (e.g. Carroll and Kimball, 2008) but also on wealth invested in

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[1] See e.g. Oikarinen (2009) for evidence on how financial market liberalization influences house prices.

[2] Mian and Sufi (2015) discuss many potential policy reforms of the mortgage and housing market.

risky assets such as housing equity; see e.g. Pelizzon and Weber (2009) and Banks et al (2010). In addition to idiosyncratic (house price) risk, or market-based risk, there are other sources of non-financial risk, or background risk, which may also induce precautionary saving. As mentioned above, one important source of risk lies in the uncertainty related to the outcome of possible future reforms. The empirical literature to date has been rather silent on how uncertainty, which stems from an insecure policy environment, affects precautionary saving. Recent studies by Giavazzi and McMahon (2012) and Ciani et al. (2015) are an exception. This is because uncertainty is normally regarded as a general concept relating to lack of knowledge about future outcomes and is not broken down into its underlying components.

The aim of this chapter is to understand how much of precautionary saving is caused by market-based uncertainty and how much is due to policy uncertainty. We focus on an important cause of policy uncertainty: a possible reduction of the mortgage interest deduction (MID). In the Netherlands, there has been, and still is, a lengthy political debate to reduce the generosity of the mortgage interest deduction.The MID is an important contribution to net household income and could also affect house prices as we will show below. Over time, the possible reform of the MID system created uncertainty about consumers' future income and housing wealth as the details of the reform remained unclear. The exact details remained unclear due to the many different views of the political parties and the uncertainty surrounding their future coalitions. This uncertainty could affect saving behavior. Our research question helps to understand how policy uncertainty can depress consumption and economic growth and what can be done to mitigate this effect, which is relevant given that an increase in saving due to policy uncertainty reduces consumer welfare, as shown by Luttmer and Samwick (2012).

To separately identify the effect of policy uncertainty on saving, we enquire whether households who tend to become more uncertain about the effect of an MID reform on house prices also tend to save more. The MID reform was a major theme in the 2010 elections and it was highly uncertain whether the reform would gain a majority in Parliament; the polls suggested that about 50 % of parliamentary seats would be taken by parties opposing the reform. We fielded our questionnaire during the weekend after the 2010 elections, just before the formation of Government. At that moment, policy uncertainty about the outcome of a possible MID reform was high. Using the Dutch CentERpanel we directly estimate the increase in uncertainty due to a possible policy reform by eliciting the subjective distribution of house prices in both a policy neutral scenario and a realistic but simplified hypothetical reform scenario.

To estimate the effect of policy uncertainty on saving, we follow the reduced-form approach put forward by Carroll and Samwick (1998). We regress the household saving rate on important background characteristics and a proxy variable for aggregate house

price uncertainty. We extend their approach by allowing for policy uncertainty: we add to the regression a term for subjective house price uncertainty attributable to the MID reform. Notice that we treat in our model house price risk in a similar way as income risk in the model of Carroll and Samwick (1998). More specifically, uncertainty about house prices signals income uncertainty in a changing policy environment. There are two reasons to expect a link between policy-related (income) uncertainty and the value of a house. First, a restrictive reform of the MID system results in a less generous tax-relief for specific groups. This means that their mortgage costs rise, leaving them with a lower disposable income and capacity to purchase a house, resulting in falling house prices and housing-market stagnation. In this case, uncertainty about house prices due to the prospective reform also reflects uncertainty about income. Second, changes in housing wealth affect future income if people are planning to annuitize housing wealth later on in life. In this case, uncertainty about house prices is a signal of a wealth effect on future income. Most of all, the attractiveness of this proxy is its simplicity, as respondents are more familiar with house prices than tax rules.

Our findings are as follows: first, we find a strong association between our subjective measures of uncertainty and regional variation in house prices. This suggests that the subjective measures of house price risk contain useful information and that homeowners do recognize both house price uncertainty and policy uncertainty. Second, households who are more uncertain about house price movements, ceteris paribus, save more than households who are less uncertain. Third, we find that policy uncertainty alone increases household saving by about two percent; a magnitude similar to that estimated by Ciani et al. 2015 using evidence from a pension reform. Although a credible reform could mitigate this effect, we also show that reforms that are not credible could ex-post exacerbate rather than mitigate the effect on precautionary saving.

2.1.1 Related literature and contribution

There are several studies on precautionary saving which are relevant to this study. Carroll and Samwick (1998) estimated the 'buffer stock model' in a reduced form. With simulations based on a CRRA (constant relative risk aversion) utility consumer, they find a high positive correlation between the target wealth to income ratio and income uncertainty. Kazarosian (1997) and Mastrogiacomo and Alessie (2013) have confirmed these results. Using different measures of uncertainty and different data sets, they showed that the share of precautionary savings attributable to income uncertainty ranges between 30% and 46% of net worth, and is therefore substantial in relative terms. These studies used panel data (such as the Panel Study of Income Dynamics, the National Longitudinal Survey and the DNB Household Survey) to determine the measure of income risk

(e.g. variance of income). Guiso et al. (1992), Lusardi (1997) and Mastrogiacomo and Alessie (2013) investigated people's actual responses by asking direct questions about their expectations on future income. The first two of the mentioned studies established the share of total savings that could be attributed to individual earnings uncertainty by regressing the logarithm of the wealth to income ratio on the subjective earnings variance, while the third study examined household income uncertainty and the subjective uncertainty about future household income expressed by both household members.

The studies referred to above investigated only the subjective distribution of income changes when institutions remain constant. We add to the literature by introducing an extra dimension to income uncertainty; more specifically, house price uncertainty which induces income uncertainty.[3] We isolate one specific source of uncertainty, namely policy uncertainty, while previous studies have only taken one total measure of uncertainty into account. Income uncertainty may stem from a range of different prospective events, including perceived unemployment risk, health deterioration, family circumstances, and so on.[4] Isolating uncertainty about fiscal policy is important because policy makers can for instance take action to reduce uncertainty by adopting credible reforms. However, they are typically unable to reduce uncertainty relating to personal circumstances.

The subject of policy uncertainty has often been investigated by macro economists and environmental economists. Pastor et al. (2012), for example, reviewed studies on the role of policy uncertainty in determining stock prices and also present a theoretical model on this topic. Baker, Bloom and Davis (2013) developed an index of economic policy uncertainty based on the number of newspaper articles which mention this topic. This method has also been used by Van der Wiel (2009) to measure the formation of expectations regarding pension benefits. Less empirical research has been conducted at the household level. Giavazzi and McMahon (2012) showed that an increase in uncertainty about the political outcome in the run-up to the 'close' German elections in 1998 resulted in a higher household saving rate. They also showed that the increase in policy uncertainty was related to a major debate about future pension reforms.

The remainder of the chapter is organized as follows. Section 2.2 describes the lengthy political debate and the formation of expectations concerning the reform of the MID over time. We also discuss the timing of our questionnaire. Section 2.3 describes the data and the design of our questionnaire. Section 2.4 discusses the measurement

[3]Nui and Van Soest (2015) analyzed the subjective distribution of house prices as well. They were mainly interested in the formation of expectations among US households. They did not consider the effect of house price expectations on saving behavior.

[4]Lusardi (1997) considered unemployment risk as potential source of income uncertainty by including regional dummies in the regression model. The point is that regional differences in unemployment might not be a good proxy of unemployment risk, as unemployment protection is high in Italy in all regions. The regional dummies are also unlikely to capture policy uncertainty as no reform of the labor market was at hand and neither expected at that time.

of idiosyncratic house price uncertainty, policy uncertainty and aggregate house price uncertainty as well as providing descriptive evidence about the quality of these measures. Section 2.5 presents the empirical model and discusses the results. The final section provide policy implications and concludes.

2.2 Expectations regarding a possible reform of the MID

The Netherlands is one of the few countries (other countries include Switzerland, Sweden and the US) where all interest paid on a mortgage loan is deductible from taxable income and so translates into a substantial tax refund. Many other countries with MID have already implemented major reforms in the past; either by abolishing opportunities for mortgage interest deduction (as in the UK) or reducing it to a large extent (as in the US).

The amount of this refund depends on factors such as the marginal tax rate, meaning that its benefit rises with income and the mortgage principal. To give an example: a household who owns a standard house, valued at around EUR 240,000, pays on average EUR 11,000 mortgage interest a year. The highest marginal income tax rate in the Netherlands is 52%. This means that such a household facing this tax rate could receive a monthly tax refund of around EUR 475, which is not too far off the monthly social assistance benefit, which equals roughly EUR 650 a month.[5] The amount that the household deducts generally does not diminish over time, since the amortization was formerly deferred either because the mortgage was interest-only, or that the amortized part was kept in a separate insurance that would fully repay at maturity. The fact that high amounts are at stake could prompt a response from liquidity-constrained, risk-averse consumers.

Faced with the high costs of these programs and some negative externalities such as inflating house prices and segregation, especially in large cities (see Glaeser et al. 2003), the Dutch government introduced some limitations to the MID system over time. In 2001 the period that a household could deduct mortgage-interest was limited to a maximum of 30 years and a second home mortgage was excluded. Various reforms have been proposed since then, however, the process has been slow and it generated considerable uncertainty. Although further reforms seemed inevitable, and indeed many lobbies were initiated, it took more than a decade, before any substantial reform of the system was seen. In April 2012, the government agreed to abolish the MID for new interest-only mortgages. This was announced in the so-called “Spring Agreement”,

[5] We refer to the average house price and average mortgage interest rate in the month of the survey.

which was reached between the government and the opposition at a time when new elections were already being planned.

Below we present prima facie evidence that the political debate about the MID affects expectations regarding the likelihood of a possible reform of the MID in the near future. The DNB household survey (DHS) is a panel study which, among other things, monitors the beliefs about a reform which reduces the generosity of the MID since 2003 (we discuss the DHS questionnaire at length in Section 2.3). The DHS asks the head of household whether the government will reduce the mortgage interest deduction: "*Do you expect a limitation of the mortgage deductibility in the foreseeable future, say 10 years?*" We consider the respondents who respond 'don't know' as feeling uncertain about a future limitation of the MID. We observe the exact week number at which the question is answered.

Figure 2.1 summarizes the evolution of these beliefs over time. The figure shows that after the 2003 political elections, 68% of the sample believed that the MID system would be reformed within 10 years. The situation remains largely unchanged after the November 2006 elections, with the DHS 2007 measurement for this period ending up at around 62%. This was a period of political instability as both elections followed a premature fall of the government. The unchanged uncertainty as shown in Figure 2.1 may reflect the assumption that the MID reform would occur only in the event of a stable majority. From then on, according to respondents, the likelihood of a reform increased. This is in line with the increasing number of political parties becoming supportive of a reform. The number of respondents who indicate uncertainty about the likelihood of a reform also gradually declined over time.

A new DHS measurement was conducted a week after the 2010 elections and just before a new coalition was created, and shows that 77% of respondents were expecting a MID reform within ten years. The reform of the MID was one of the major themes during the 2010 elections. Also our separate questionnaire to measure house price uncertainty was sent out in the week of the 2010 elections, since we had noticed that it was highly uncertain at that time whether there was a majority coalition in favor of a reform. According to the polls in terms of Parliamentary seats in the week preceding the questionnaire both opponents and supporters of a MID reform represented about half of the seats in Parliament. The possible reform of the MID system created uncertainty about house prices and future income as the outcome of the coalition formation and exact institutional details about a limitation of the MID remained unclear.

Two years later, and a few weeks before the MID reform was first announced in the Spring Agreement,[6] the 2012 DHS measurement was conducted. About 85% of

[6]The Spring Agreement was an agreement between the opposition and the remaining parties supporting government, after the former coalition government had failed.

the households believed in the possibility of an MID reform possibly because of the severely deteriorated economic outlook. The latest elections were held in September 2012; and a few weeks later the MID reform became official. Three days after the reform-announcement, we filed a new questionnaire, in order to elicit the opinion of respondents now that the reform had been made public and the treated group appeared to be much smaller than expected. The reform came as a surprise, not only because finally an agreement had been reached, but also because it did not involve all existing mortgages, which was highly unexpected according to our data (80% of the sample did not expect only new starters to be subject to the new amortization rules).[7] Thus, despite the fact that the government reformed the MID, according to the 2013 DHS measurement, the majority of households expected new or additional reforms (75%). We also observe a noticeable increase in uncertainty about possible new reforms in the future. This suggests that the implemented reforms were not felt as being definitive as households are more uncertain and expect additional policy measures in the future. This is also confirmed by the follow-up survey which was fielded three days after the MID reform was announced (see also figure 2.1). We discuss the results of the 2012 measurement in section2.6.

2.3 Data

In order to measure house price uncertainty we have designed a detailed questionnaire. We will discuss this questionnaire in detail below. We have also sent out a follow-up survey immediately after the MID reform, to measure the credibility of the announced reform. In our study, we will merge the questionnaire on house price expectations with the the 2010 wave of the DNB household survey (DHS). The DHS was launched in 1993 and is the main survey based on the CentERpanel. The CentERpanel is an Internet based panel of over 2,000 households administrated by CentERdata at Tilburg University and sponsored by De Nederlandsche Bank. The panel is representative of the Dutch population. Panel members without Internet access receive a set-top box and equipment that enables them to participate through their television.

For each wave of the DHS, information has been collected by means of five questionnaires: household and work, accommodation and mortgages, health and income, assets and liabilities and economic and psychological concepts. These questionnaires, except the second one on accommodation and mortgages, should be filled in by all respondents, i.e. those household members who are at least sixteen years old. The housing and accommodation questionnaire is in principle filled in by the head of household. The five questionnaires have been launched at different weeks of the year so that the number of

[7] Results are available upon request.

responding households differs across the questionnaires. CentERdata also provides the data set with 'general information of the household' which contains demographic and socio-economic information for all members—also those who are younger than 16—for households who responded to at least one of the 5 questionnaires mentioned above. In our study we use the following information available in this data set: age, marital status, education level, disposable income (in brackets), a dummy variable indicating homeownership status, the number of cohabiting children, and a dummy variable indicating self-employment. We will only consider the answers of the head of household.

Our question of interest is whether household saving reacts to an increase in house price uncertainty due to a reform of the MID. Following Giavazzi and McMahon (2012) we will use active saving as a percentage of permanent income as the dependent variable.

The DHS questionnaire on economic and psychological concepts elicits information on active saving by asking the respondents whether or not the household has saved in the past year and if yes how much. The amount of saving is reported in brackets. We take the mid value to represent active saving. This saving measure does not take the possibility of negative active saving into consideration. The minority of heads of households who answered that they did not save might either have no saving or a negative saving rate. We identify respondents with negative saving by means of the question: "*Would you say the expenditures of your household were higher than the income of the household, about equal to the income of the household, or lower than the income of the household?*" We impute the amount of negative active saving using the difference in financial wealth. We transform this into a negative active saving bracket similar to the question of active saving. For the few households who do not report the amount of saving we impute saving in the same way. Permanent income has been estimated using the procedure of Kapteyn et al. (2005).[8]

Alternatively, the longitudinal nature of the DHS also allows us to measure saving by taking the first difference of net worth. The advantage of the active saving measure is that it is less prone to measurement error than using the first difference in net worth. Moreover, the difference in net worth might not measure true intended savings because of unanticipated capital gains in the housing market or stock market which is difficult to take into consideration.

In our regression analysis, we also account for expectations concerning the general economic situation of the household which is derived from the question: "*How do you think the economic situation of your household will be in five years time in comparison to the current situation*?" We assume that this dummy variable—of an improved economic situation of the household—is a good proxy for income expectations. As a proxy for income uncertainty, we derive the variance of the subjective probability to become

[8]Kapteyn et al. (2005) provide details on the estimation of permanent income.

unemployed (or to find a job) in the next 12 months by the head of household.[9] Unemployment is for sure one of the main sources of income uncertainty. The information on income uncertainty is available in the DHS questionnaire on health and income. We also use information on whether or not the head of household is self-employed since this group of workers experience a greater uncertainty of income.

2.3.1 Questionnaire on house price uncertainty

The questionnaire was fielded in the CentERpanel during the weekend of June 18, 2010. Within each household both the head and the partner aged 20 or above were interviewed. The questionnaire has been presented to 2,184 household members of which 1,465 members (1003 households) have completed the questionnaire; this implies a response rate of 67 percent at the individual level. This corresponds to the response rates to the modules of the annual DHS (Teppa and Vis 2012).

We create a variable measuring the number of years in which the respondent expects an announcement of the reform by the government. Next, in the questionnaire we ask homeowners about expectations regarding the value of their own property, in the short-term (next two years), if no reform were to be implemented. Tenants are asked about general price movements on the housing market. We use the question:

"Suppose that the government decides not to change the tax treatment of owner-occupied housing. This implies that the mortgage interest deduction remains unaltered. What is the change out of 100 that the value of your property will (increase/decrease) between y_k % and y_{k+1} % in total within the next two years?"

Each respondent reports the probability of a price movement within five specific intervals $[y_k, y_{k+1}] : k = 1, ..., 5$. We present all five intervals at the same time to the respondent and provide instructions that the probabilities should add up to 100. We randomly present the intervals in increasing or decreasing order as the order might affect response behavior. The intervals are respectively $(-\infty, -15]$, $(-15, -5]$, $(-5, 5]$, $(5, 15]$, $[15, \infty)$. The first and final interval are not bounded. We assume that the maximum change of the value of the own property is 30 percent. The respondents are also given the possibility to answer 'don't know' if they are unsure about future price movements.

Next, we confront each respondent with one of three hypothetical and simplified reform scenarios that the Dutch Social Economic Council (SER) had proposed to the Government in 2010.

1. The maximum rate at which the mortgage interest can be deducted will reduce from 52% to 30%, in small steps of 1%-point per year.

[9] The variance of the probability p to find or loose a job in the next 12 months is $p(1-p)$.

2. The maximum amount over which mortgage interest can be deducted will be reduced from EUR 500,000 to EUR 250,000, in small steps of approximately EUR 11,000 per year. Interest on loans above EUR 250,000 will then no longer be tax-deductible.
3. The primary residence and the mortgage will receive the same fiscal treatment as taxable wealth. In other words, the maximum rate at which the mortgage interest can be deducted will reduce to 30% in 22 years . A Mortgage interest of 4% will be assumed, irrespective of the actual interest rate. The imputed rent on the owner-occupied house will be abolished by then with housing wealth taxed in the same way as savings and investments (i.e. an effective wealth tax of 1.2 %).

For all the three reform scenarios, we mention that they will be implemented gradually (starting in five years) and that they hold for both existing and new mortgage contracts. We randomly assign the respondents to one of the above simplified reform scenarios:[10]

We then asked the homeowners again about their housing value uncertainty in the short-term assuming that one of the hypothetical scenarios will be implemented. Tenants are asked about price movements on the housing market. We use the question:

"Suppose that the government will announce tomorrow that they gradually change the tax treatment of owner-occupied housing. The reform will be implemented in steps in five years after the announcement and will be fully implemented in 22 years of time. [Simplified reform scenario 1., 2. or 3. is stated here.] *What is the change out of 100 in this scenario that the value of your property will (increase/decrease) between y_k % and y_{k+1} % in total within the next two years?"*

Next, we repeat the previous question and ask about price movements (in the same scenario) but ask about expected price movements in the long-term (next ten years). Table 2.1 provides the mean and standard deviation of the reported probability distribution of the (cumulative) price movement of the own property in the no-reforms scenario (in the next two years) and the reform scenario (in the next two years and next ten years).

A considerable fraction of the respondents state that they are "unsure" about future price movements in the no-reform scenario (37%) and this fraction further increases in the reform scenario in the next two years (48%). These households are excluded from the

[10]The respondents were also asked how they expect the MID would be reformed. A list of 14 policy options was presented to them. The most popular answers correspond to the simplified scenarios: more than half (54%) of the respondents indicate that the MID would be reformed for mortgages above a certain threshold, while 35% answers that the rates at which mortgage interest could be deducted from tax would be reduced and approximately 38% believes that the MID would be slowly phased out. The results of this questionnaire are available upon request.

empirical analysis.[11] We also drop 26 households who provide incomplete information to derive the subjective distribution function about future house price movements. This leaves us with 487 households of which 84 percent is homeowner. Upon merging our questionnaire with the DHS the final sample further reduces to 410 households.

Table 2.2 provides summary statistics for the variables used in the empirical analysis.

2.4 Measuring house price uncertainty

Next, we derive separate measures of house price uncertainty which both exclude policy uncertainty (we refer to this measure as 'market-based uncertainty') and include policy uncertainty (we refer to this measure as 'aggregate house price uncertainty'). We assume that aggregate house price uncertainty depends on general house price uncertainty and policy uncertainty due to a possible reform of the MID.

Suppose that the random variable Y is the price movement of the own property (or average property for tenants) in the next two years. We assume that the distribution of Y depends on (1) a dummy variable R where individuals can either deduct mortgage interest from income tax (no-reform scenario: $R = 0$) or where the deduction of mortgage interest is substantially reduced or abolished all together (reform scenario: $R = 1$) and (2) the probability that the government will reduce the MID, i.e. $\Pr(R = 1)$.

To proxy the probability that the government limits the MID $\Pr(R = 1)$ we use a probit model:

$$\Pr(R = 1|X) = \Phi(X'\beta), \tag{2.1}$$

where R is a dummy variable whether or not the respondent expects a limitation of the MID in the foreseeable future (see section 2.2 for the exact formulation of the question), X is a vector of regressors from our questionnaire which are good predictors of this probability and Φ is the CDF of the standard normal distribution. We use the following regressors: a dummy variable whether or not the respondent expects a reform of the MID and a variable measuring the number of years in which the respondent expects an announcement of the reform. Most respondents indicated that they think that the Dutch government would announce a reform of the MID system within two years. Figure 2.2 shows the distribution of the predicted probability of a reform $Pr(R = 1)$. The figure shows that the large majority assigns a high likelihood to a reform of the MID in the short-term.[12]

[11] This group of 'sure' respondents is more often homeowner, higher educated and richer than 'unsure' respondents.

[12] As a robustness check we also pretend that R equals the probability that the government limits the MID. We do not observe this variable for 90 observations in our sample. This does not affect the results

To derive the conditional cumulative distribution function $F_i^r(y) = P_i(Y \leq y|R = r)$ we use the reported probability distribution by the respondent. We denote the reported probabilities as p_{ik}^r, $k = 1, \cdots, 5$, where $p_{ik}^r = p(y_k \leq Y_i \leq y_{k+1}|R = r)$, with $r = \{0, 1\}$.

After dividing the reported probabilities p_{ik}^r by 100 we can derive the five revealed points on the respondents 'subjective' cdf

$$F_{ik}^r(y_k) = P_i^r(Y \leq y_k|R = r) \equiv \sum_{l=1}^{k} p_{il}^r. \tag{2.2}$$

For each respondent we can fit a log-normal cumulative distribution function through the revealed points of the 'subjective' cdf using the method of nonlinear least squares —following Dominitz and Manski (1997). That is, for each respondent i, we find the parameters μ_i^r and σ_i^r that minimize the sum of squared deviations between the point on the 'subjective' cdf and the log-normal cdf

$$\min_{\mu_i^r,\, \sigma_i^r} \sum_{k=1}^{6} \left[F_{ik}^r(y_k) - \Phi\left(\frac{\ln(y_{ik}) - \mu_i^r}{\sigma_i^r} \right) \right]^2, \tag{2.3}$$

where $\mu_i^r = E[\ln(Y_i)|R = r]$ and $\sigma_i^{r\,2} = \text{var}[\ln(Y_i)|R = r]$ respectively represent the mean and variance of the price movement. Next, we can easily compute the conditional expectation $E[Y_i|R] = exp(\mu_i^r + \frac{1}{2}\sigma_i^{r\,2})$ and the conditional variance $\text{var}[Y_i|R] = exp(2\mu_i^r + 2\sigma_i^{r\,2}) - exp(2\mu_i^r + \sigma_i^{r\,2})$. We make sure that the standard deviation is zero when the respondent is 100 percent certain that the price movement falls in one interval.

We also derive the subjective probability distribution of Y by fitting a cubic spline function through the five revealed points of the cumulative distribution function— following Bellemare et al., 2012). This is a more flexible method to derive the subjective probability distribution and results in very similar statistics. We use this as our preferred measure of house price uncertainty in the empirical analysis. The results are quantitatively the same. We find a correlation between the interquartile range (IQR) of the non-parametric (cubic spline) distribution and the IQR of the log-normal distribution of 0.92.

The above measures allow us to derive the unconditional variance, or the 'aggregate' uncertainty. The unconditional variance is a convex function of the conditional variance in both scenarios.[13]

for both the relation between house price uncertainty and precautionary saving and policy uncertainty and precautionary saving.

[13]More specific, the unconditional variance of Y given $X = x$ is defined by $\text{var}[Y|X = x] = E[Y^2|X = x] - (E[Y|X = x])^2$, where $E(Y^2|X = x) = E[E(Y^2|R, X = x)] = E(Y^2|R = 0, X = x)Pr(R = 0|X = x) + E(Y^2|R = 1, X = x)Pr(R = 1|X = x)$, and where $E(Y^2|R = r, X = x) = \text{var}[Y|R = r, X = x] + (E[Y|R = r, X = x])^2$. The unconditional expectation of Y is given by $E(Y|X = x) =$

Table 2.3 reports the average expected value of the subjective probability distribution of price movement of the own property in different scenarios. The reported values are derived using the cubic splines. The table shows that households on average expect a minor increase in house prices of 0.33 percentage points in the no-reform scenario and a small decline of -1.92 percentage points after a reform of the interest deduction. The average variability of expected house price movements increases slightly. The increase in uncertainty is, on average, not statistically significant. We do observe a significant increase in the variance of price movements in the reforms scenario in the long-term (after ten years). Unfortunately, we cannot distinguish whether the increase in the variance in the long-term is caused by the reform or by the longer time span which makes predictions more uncertain, since we do not have information about long-term uncertainty in a policy neutral scenario.

There are different ways in which a reduction in the mortgage interest deduction can be accomplished. To test whether responses differ depending on how the limitation on tax deductibility occurs we randomly assigned the respondents to three different policy reforms of the MID (see above). We use an F-test to assess whether the average value of the mean expected price movement within the three groups differ from each other. There are no significant differences between the group means for both the IQR and expected value for all scenarios. In the empirical analysis we will, therefore, not distinguish between the different groups.

2.4.1 Quality of our measurement

To examine whether the calculated measures of subjective house price uncertainty contain useful information we will relate the subjective measures to actual house price risk. As a measure of actual house price risk, we use the variation in house price movements within the region of residence of the household. Studies by Banks et al. (2010) and Gathergood (2011) show that regional variation in house prices is an important determinant for household financial decision making in the US and the UK, such as the accumulation of home equity, investment behavior and homeownership choice.

We use aggregate information for 76 regions on house prices. This information is provided on a quarterly basis by NVM which is the largest association of real estate agents in the Netherlands and represents almost 70 percent of the Dutch housing supply. We merge this data to the respondents in our questionnaire according to the regional postcode (i.e. first two digits). Some postcode areas fall into more than one neighboring region. For these households we calculate the weighted average of these measures according to the population size of each region in which the postcode falls. For each re-

$E[E(Y|R, X = x)] = Pr(R = 0|X = x)E(Y|X = x, R = 0) + Pr(R = 1|X = x)E(Y|X = x, R = 1)$.

spondent we calculate the standard deviation of regional house price movements in the five year period around the time of our questionnaire, between 2008 and 2012, following the procedure of Banks et al. (2010). This period elicits also the boom-bust cycle of house prices. We observe sizable differences in both the volatility and movements in house prices across regions for this period (as reported in Table 2.4).

Table 2.5 shows that the region-specific actual house price risk is significantly associated with the perceived house price risk in the short-term by the head of household as measured in our questionnaire. This suggests that households do recognize both house price uncertainty and policy uncertainty.[14]

2.5 Empirical model and results

The starting point of our empirical analysis is the buffer stock model developed by Carroll and Samwick (1998). Using simulations based on a CRRA utility function, they notice that a reduced form model for savings could be estimated with a 99% fit. This model shows that the logarithm of savings divided by permanent income correlates with the variance of the logarithm of income—which is a proxy of uncertainty—and a polynomial in age since the life cycle model postulates a non-linear relation between savings and age. Following Giavazzi and McMahon (2012), we use the ratio of active savings to permanent income s as our dependent variable, instead of the accumulated savings to permanent income, since an increase in the flow of saving due to increased policy uncertainty because of a reform of the MID will probably not immediately result in a higher 'buffer stock' of wealth.

To determine whether precautionary saving is affected by aggregate (i.e. uncondition) house price uncertainty, we first estimate the following equation:

$$s_i = \beta_0 + \sum_{a=2}^{5} \delta_a \text{Ageclass}_{ai} + \beta_1 \text{IQR}_i + \beta_2 \mu_i + x_i' \theta + \epsilon_i, \tag{2.4}$$

where IQR measures the subjective aggregate house price uncertainty, Age is a dummy variable which equals one if the head of household falls within an particular age group a and zero otherwise, μ_i is the expected value of the house, and x_i is a vector of control variables. The control variables include demographic factors such as marital status (living together with a partner) and the number of children to account for variation in

[14] The excess supply of houses, or market tightness, on the regional level is also significantly related to perceived house price risk (not reported but available upon request). For example, Mian and Sufi (2014) show that excess supply within US regions plays an important role in the adjustment process of house prices and consequently for house price risk.

tastes over the life cycle and other important determinants of saving such as the level of education, household income (in categories) and homeownership status. We also account for expectations concerning the general economic situation of the household which might be correlated with house price risk. We include a dummy variable for self-employment to account for income uncertainty. We also experimented with the variance of the subjective probability to become unemployed as a proxy for income uncertainty. This variable is, however, not available for the full sample. The exclusion of income uncertainty results in virtually similar estimation results. Moreover, the coefficient of income uncertainty is never statistically significant. We, therefore, decide to leave this variable out of the regression model.

To separate the contribution of policy uncertainty on precautionary saving we subsequently estimate the equation:

$$s_i = \beta_0 + \sum_{a=2}^{5} \delta_a \text{Ageclass}_{ai} + \beta_1 \Delta \text{IQR}_i + \beta_2 \Delta \mu_i + \beta_3 \text{IQR}_i^0 + \beta_4 \mu_i^0 + x_i' \theta + \epsilon_i, \quad (2.5)$$

where ΔIQR_i equals $\text{IQR}_i^1 - \text{IQR}_i^0$ which measures policy uncertainty: the additional uncertainty—over and above the house price uncertainty in a policy neutral scenario IQR_i^0—due to a possible reform of the MID. We estimate the effect of policy uncertainty on precautionary saving both in the short-term (two years time) and long-term (ten years time). We use the same set of controls as in the previous equation.

2.5.1 Results for policy uncertainty

Table 2.6 reports the parameter estimates for the household active saving rate (expressed as the ratio of active saving to permanent income). We first examine whether aggregate (or unconditional) house price uncertainty is related to precautionary saving behavior (model 1). We find a positive but non-significant coefficient for aggregate uncertainty. Thus, we do not find strong evidence that households who are more uncertain, with respect to short-term house price movements indeed, save more.

Next, we examine whether those who perceived higher potential house price risk due to the change in policy (i.e. policy uncertainty) cumulate more saving. In this specification we control for idiosyncratic house price risk (i.e. market-based uncertainty) in a scenario without reforms of the MID (model 2). We find a positive and significant relationship between policy uncertainty and precautionary saving. Households who perceive higher policy uncertainty have, ceteris paribus, a higher saving rate than households who are less uncertain about new policy.

We can use the estimated coefficients to assess the importance of policy uncertainty

with respect to total saving. We find that policy uncertainty due to a possible reform of the MID accounts for about 1.6 percent of total saving.[15] Thus, policy uncertainty only results in a limited amount of additional saving.

In model 3, as a robustness check, we replace our measure of perceived market-based uncertainty by our measure of aggregate uncertainty. We thus test whether policy uncertainty, keeping aggregate uncertainty constant, results in more saving. This specification is less clean than specification 2, in the sense that aggregate uncertainty is a compound of policy uncertainty and market-based uncertainty. We again find that policy uncertainty (ceteris paribus) results in a significantly higher saving rate.

Next, we re-estimate the models for the measures of uncertainty over the 10 year period. Model (4) shows that aggregate house price uncertainty is again positively (but now also significantly) related to precautionary saving. We also find that over a longer time-span, policy uncertainty results in a significant higher saving rate (model 5). For the 'less clean' specification (model 6) the effect of policy uncertainty turns out not to be significant.

We also tried to estimate models 2 and 4 using instrumental variables (IV). The reason for resorting to IV estimation is that our subjective distribution of house prices, using the hypothetical questions, could be measured with error which results in biased estimates towards zero and, therefore, underestimates the importance of policy uncertainty for precautionary saving. The set of explored instruments is the volatility in house prices in the region of residence of the household (or actual house price risk). We also include market tightness within the region of residence as an instrument. We have shown that both instruments are relevant predictors for subjective house price uncertainty.

The firststage regression, however, shows that explanatory power of the instruments is rather low (not reported but available upon request). As a result, we refrain from using IV since the F-statistic indicates a weak instrument (Staiger and Stock, 1997) and we are therefore unable to say anything about the exact magnitude of the estimated effects, our estimates are at the lower bound. Other papers that use region-specific measures of uncertainty to instrument subjective uncertainty also suffer from weak instruments; see Lusardi (1997).

Some groups might be more sensitive to policy uncertainty regarding a reform of the MID, for example homeowners, households who expect a reform in the near future or households with a large precautionary savings motive. To test whether specific subgroups respond differently to a possible reform of the MID we distinguished between five subgroups as defined in Table 2.7. We include a dummy variable for the subgroup and an interaction between the subgroup and the variable measuring policy uncertainty

[15] $\hat{\beta}_1 \overline{\Delta_{\text{IQR}}}/\bar{s} = .005 \times .382/.121 = .0158$. The sample means are reported in Table 2.2.

(ΔIQR). This interaction effect measures whether there is a difference in the effect of policy uncertainty on precautionary savings between both groups. Within each subgroup we do not find a significant difference in the response to policy uncertainty (see Table 2.8).

2.6 Policy discussion

Following the premature fall of the Dutch Government in 2012, the newly elected Government announced plans to reform the MID. The reform became effective as from 1 January 2013. The reform is, however, not comprehensive since it immediately limited the tax relief only for new mortgage contracts and most current MID receivers are not affected. Those who were affected by the reform will only lose a small part of their MID in 28 years and only if they belong to the highest tax bracket. The news of the MID reform was given huge media coverage, and at the end of the week in which the announcement was made we re-interviewed our sample to examine whether policy uncertainty was taken away by the reform.

Table 2.9 shows the answers to the question whether respondents think that the reform will be definitive in the long-term. Only 12.5% of the respondents believe that there will be no new reforms in a period of twenty years, while 54% thinks that new reforms will be announced in five years. We then asked about their response to the current reform. Table 2.10 shows selected answers from an originally larger list. The majority of the respondents answer that they will not do anything in response to the reform. Those who will take action are planning to save more, also 13.9% of the homeowners who were left unaffected by the reform are planning to save more.

This is a striking finding. In the questionnaire which was held before the MID reform, when policy uncertainty was highest, 4.1% of the respondents was planning to save more. After the reform, when policy uncertainty was taken away, the potential additional savings tripled. One way to interpret this finding is that respondents saw the limited reach of the reform and did not believe that it could be definitive. This suggests that both delaying expected reforms and reforming in a non-credible way may depress consumption. Of course, the deteriorated economic outlook between 2010 and 2012 might also have driven the rise in potential savers, however, the other potential behavioral responses (e.g. selling, moving, working more) did not show such dramatic changes as that of the amount of savers.

Finally, Table 2.11 shows expectations about the future development of several market fundamentals, such as price levels, transactions and uncertainty. Respondents expect that price levels and the number of transactions will fall, which is hardly surprising following the restrictive reforms for new buyers. The surprising result is that a large

majority of respondents indicates that the reform has fueled rather than dampened uncertainty. Combining this with the statement about additional savings, it is not evident at all that the present MID reform has mitigated policy uncertainty.

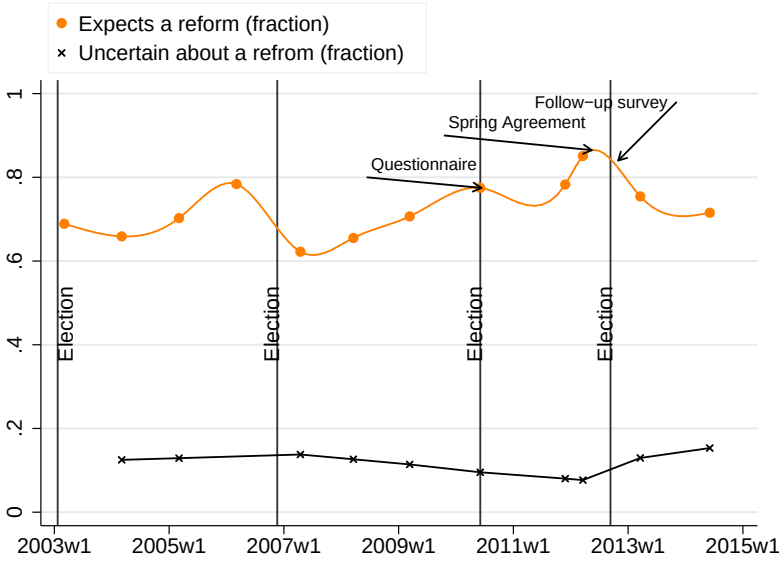
2.7 Conclusions

We investigated the separate effect of policy uncertainty caused by a possible reform of the MID system in the Netherlands on precautionary saving. Asking questions about standard market-based uncertainty and uncertainty linked to a hypothetical reform of the MID, we unraveled the effect of policy uncertainty on precautionary saving. This is a novel contribution. We show that the contribution of policy uncertainty to total saving alone is modest as it accounts for about two percent of total saving. While the influence of policy uncertainty is small it is nontrivial and by taking away this uncertainty consumer welfare will increase.

The Government could reduce policy uncertainty by implementing credible policy, i.e. policies that could induce consumers to believe that the future policy environment will stay constant. Thanks to the unique timing of our questions, asked at crucial moments in the reform process, we were able to show how policy uncertainty can actually increase after a reform is announced, should the reform not be considered definitive.

2.8 Tables and figures

Figure 2.1: Do you expect a limitation of the mortgage deductibility in the next 10 years?



Source: DHS 2003-2014.

Table 2.1: Subjective probability distribution of cumulative price movement of the own property (in percentage points) in different scenarios

	Homeowner			Tenant		
	No-reform	Reform 2 year	Reform 10 year	No-reform	Reform 2 year	Reform 10 year
$p \geq 15$	6.57	5.07	11.59	9.26	7.85	12.37
	(11.24)	(8.57)	(19.45)	(12.62)	(13.67)	(16.50)
$5 < p < 15$	23.06	16.86	22.00	23.40	19.53	23.70
	(22.32)	(19.57)	(22.11)	(21.18)	(19.09)	(21.16)
$-5 < p < 5$	44.20	41.82	35.61	37.69	37.00	30.75
	(26.71)	(26.64)	(26.82)	(25.15)	(23.24)	(22.14)
$-15 < p < -5$	18.28	24.35	19.72	18.94	24.57	21.27
	(17.84)	(20.71)	(20.10)	(18.07)	(20.07)	(20.89)
$p \leq -15$	7.89	11.90	11.09	10.71	11.06	11.91
	(13.07)	(18.08)	(18.64)	(15.49)	(13.93)	(17.95)
Do not know	0.31	0.45	0.47	0.56	0.70	0.72
	(0.46)	(0.50)	(0.50)	(0.50)	(0.46)	(0.45)
Observations	1,032			359		

Notes: N=1,391.

Figure 2.2: Distribution of the $Pr(R = 1)$, head of household (N=487)

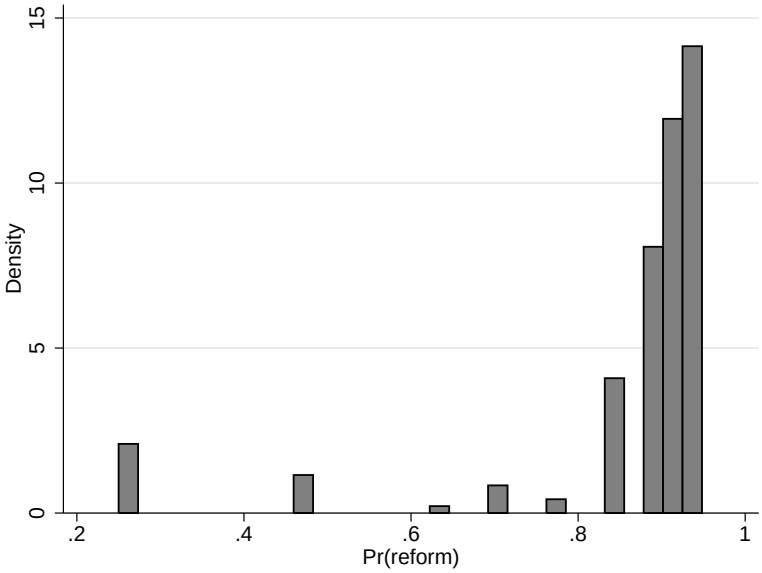


Table 2.2: Summary statistics

	Mean	Std. Dev.
Saving rate (ratio of active saving to permanent income)	0.121	0.190
No. of children	0.561	0.993
Married	0.705	0.457
Self employed	0.041	0.20
Homeowner	0.841	0.366
Higher educated	0.529	0.50
Improved econ. situation	0.188	0.391
Income uncertainty	0.045	0.075
Y< EUR 1,150	0.037	0.188
EUR 1,151 < Y < EUR 1,800	0.166	0.372
EUR 1,801 < Y < EUR 2,260	0.256	0.437
Y > EUR 2,260	0.541	0.499
Age 20-34	0.083	0.276
Age 35-44	0.159	0.366
Age 45-54	0.198	0.399
Age 55-64	0.305	0.461
Age 65+	0.256	0.437
Δ_{IQR}	0.382	4.125

Notes: N=410. The variable 'income uncertainty' is available for 387 households.

Table 2.3: Average expected value and average interquartile range of the subjective distribution of house price movement (in percentage points) derived using splines, head of the household.

	Group 1	Group 2	Group 3	All	F-test (p-value)
Expected value					H_0 : $\mu_1 = \mu_2 = \mu_3$
No-reform scenario (next two years)	0.42	0.41	0.18	0.33	0.92
	(5.88)	(6.41)	(5.33)	(5.86)	
Reform scenario (next two years)	-2.33	-1.11	-2.25	-1.92	0.16
	(6.24)	(6.13)	(6.66)	(6.37)	
Reform scenario (next ten years)	0.00	1.41	0.35	0.55	0.37
	(8.68)	(8.43)	(9.18)	(8.79)	
F-test. $H_0 : \mu_{\text{no-reform}} = \mu_{\text{reform}}$:	next two years (p-value)			0.00	
	next ten years (p-value)			0.00	
Interquartile range (IQR)					H_0 : $\text{IQR}_1 = \text{IQR}_2 = \text{IQR}_3$
No-reform scenario (next two years)	9.19	9.84	8.86	9.28	0.28
	(5.40)	(6.09)	(5.29)	(5.60)	
Reform scenario (next two years)	9.76	9.50	9.57	9.61	0.91
	(5.32)	(5.25)	(5.93)	(5.51)	
Reform scenario (next ten years)	9.72	10.26	10.42	10.13	0.56
	(5.89)	(5.66)	(6.29)	(5.96)	
F-test. $H_0 : \text{IQR}_{\text{no-reform}} = \text{IQR}_{\text{reform}}$:	next two years (p-value)			0.36	
	next ten years (p-value)			0.02	
Observations	162	154	171	487	

Notes: Standard deviation is given within parentheses. F-test: equality of means test for the three randomized groups. Group 1: The maximum rate at which the mortgage interest can be deducted will reduce to 30%. Group 2: The maximum amount over which mortgage interest can be deducted will be reduced to EUR 250,000. Group 3: The primary residence and the mortgage will receive the same fiscal treatment as taxable wealth.

Table 2.4: Frequency distribution of regional house price volatility (%) and movement between 2008 and 2012, head of household

S.D. of house price movements (within the region of residence)a	%	Percentage price decline (within the region of residence)b	%
0.00 — 0.04	0.0	0.00 — 0.05	6.0
0.04 — 0.06	22.0	0.05 — 0.10	29.2
0.06 — 0.08	44.6	0.10 — 0.15	38.6
0.08 — 0.10	24.6	0.15 — 0.20	21.8
0.10 — 0.12	4.3	0.20 — 0.25	3.9
0.12 — 0.14	4.5	0.25 — 0.30	0.6
Average	0.076	Average	0.118
Median	0.074	Median	0.112
SD	0.019	SD	0.048

Notes: N=410. [a] $SD(\text{log price index}_t - \text{log price index}_{t-1})$, where t is the value of the index in the first quarter of the stated year. [b] $\text{log price index}_{2012Q1} - \text{log price index}_{2008Q1}$

Table 2.5: Association between subjective house price uncertainty (interquartile range) and 'actual' house price risk, dependent variable: subjective house price uncertainty, head of household

	Conditional IQR			Uncondition IQR	
	No-reform	Reform	Reform		
	Two years	Two years	Ten years	Two years	Ten years
S.D. of house price movements (within the region of residence)	38.117**	25.704*	23.483	27.135*	24.414
	(16.382)	(13.813)	(17.153)	(14.214)	(16.838)

Notes: N=410. Results of a multivariate regression for the head of the household. Included controls: see regression Table 2.6. Standard errors clustered at the postcode level in parentheses. Significant at the *** 1 percent; ** 5 percent; * 10 percent level.

Table 2.6: Effect of policy uncertainty on precautionary saving, dependent variable: saving rate (ratio of active savings to permanent income)

	(1)	(2)	(3)	(4)	(5)	(6)
	Short-term (two years)			Long-term (ten years)		
IQR	0.003		0.002	0.004**		0.004*
	(0.002)		(0.002)	(0.002)		(0.002)
μ	0.003**		0.003**	0.003***		0.003***
	(0.002)		(0.002)	(0.001)		(0.001)
ΔIQR		0.005**	0.019***		0.004**	0.005
		(0.002)	(0.007)		(0.002)	(0.010)
$\Delta\mu$		0.003**	0.003		0.002**	-0.006
		(0.002)	(0.007)		(0.001)	(0.006)
IQR^0		0.002			0.003	
		(0.002)			(0.002)	
μ^0		0.003			0.003	
		(0.002)			(0.002)	
Age 20-34	0.071*	0.068*	0.070*	0.061*	0.061	0.063*
	(0.037)	(0.036)	(0.037)	(0.037)	(0.038)	(0.037)
Age 35-44	0.072**	0.069**	0.068**	0.067*	0.066*	0.066*
	(0.034)	(0.034)	(0.034)	(0.036)	(0.037)	(0.036)
Age 45-54	0.043	0.040	0.044	0.029	0.029	0.031
	(0.034)	(0.033)	(0.034)	(0.033)	(0.033)	(0.033)
Age 55-64	0.008	0.006	0.008	0.006	0.005	0.006
	(0.025)	(0.025)	(0.025)	(0.028)	(0.028)	(0.028)
Y < 1,150	-0.150***	-0.151***	-0.149***	-0.151***	-0.149***	-0.150***
	(0.035)	(0.036)	(0.035)	(0.039)	(0.039)	(0.039)
1,151 < Y < 1,800	-0.127***	-0.130***	-0.131***	-0.133***	-0.131***	-0.133***
	(0.030)	(0.030)	(0.030)	(0.032)	(0.032)	(0.033)
1,801 < Y < 2,260	-0.051***	-0.052***	-0.050***	-0.047**	-0.046**	-0.048***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
Married	-0.040	-0.042	-0.041	-0.042	-0.042	-0.042
	(0.027)	(0.026)	(0.026)	(0.027)	(0.027)	(0.027)
No. of children	-0.023**	-0.023**	-0.023**	-0.026***	-0.026***	-0.025***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Homeowner	-0.004	-0.007	-0.003	-0.018	-0.020	-0.016
	(0.033)	(0.034)	(0.033)	(0.037)	(0.039)	(0.038)
Higher educated	0.044**	0.044**	0.044**	0.035*	0.034*	0.034*
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Self employed	0.064	0.063	0.066	0.062	0.063	0.064
	(0.082)	(0.082)	(0.082)	(0.094)	(0.094)	(0.094)
Improved econ. situation	-0.045*	-0.043*	-0.046**	-0.038	-0.039	-0.041*
	(0.023)	(0.022)	(0.022)	(0.024)	(0.025)	(0.024)
Constant	0.140**	0.148**	0.143**	0.145**	0.151**	0.144**
	(0.056)	(0.058)	(0.056)	(0.061)	(0.066)	(0.062)
Adjusted R^2	0.091	0.089	0.093	0.103	0.097	0.099
N	410	410	410	382	382	382

Notes: Regression results for the head of household. Robust standard errors between parentheses. Significant at the *** 1 percent; ** 5 percent; * 10 percent level.

Table 2.7: Overview of the defined subgroups

	Subgroup	Frequency (%)
1	Expects a reform of the MID in the near future	60.7
2	Strong precautionary savings motive	71.2
3	Homeowner	84.1
4	Already takes measures (e.g. saves more)	17.8
5	Reports an increase in policy uncertainty (due to a possible reform) versus a decline in uncertainty.	46.1

The subgroups are dichotomous variables; yes (=1) or no (=0).

Table 2.8: Effect of policy uncertainty on precautionary saving for different subgroups, dependent variable: saving rate (ratio of active savings to permanent income)

	(1)	(2)	(3)	(4)	(5)
Subgroup $\times\Delta_{\text{IQR}}$	-0.000	-0.004	-0.001	-0.002	-0.001
	(0.003)	(0.004)	(0.004)	(0.003)	(0.006)
Subgroup	0.052***	0.007	-0.006	-0.013	0.018
	(0.016)	(0.020)	(0.034)	(0.020)	(0.020)
Δ_{IQR}	0.005**	0.007**	0.005	0.005*	0.004
	(0.002)	(0.003)	(0.005)	(0.003)	(0.005)

Notes: Regression results for the head of household. Robust standard errors between parentheses. Significant at the *** 1 percent; ** 5 percent; * 10 percent level. The table reports possible heterogeneity in precautionary savings. A description of the five subgroups is provided in Table 2.7. The variable 'Subgroup' is an indicator variable for the subgroup as reported in this table. The interaction effect measures whether there is a difference in the effect of policy uncertainty on precautionary savings between both groups. Includes the same set of controls as in Table 2.6 (not reported but available upon request).

Table 2.9: Opinion about future reforms, head of household

No, there will be no new reforms in the next 20 years	12.5%
Yes, I expect new reforms within 2 years	14.9%
Yes, I expect new reforms within 2—5 years	39.1%
Yes, I expect new reforms within 5—10 years	25.5%
Yes, I expect new reforms within 10—20 years	7.9%

Source: 2012 Follow-up questionnaire. (N=1319). We use sample weights to make sure that the reported statistics are representative of the Dutch population age 25 and above. The sample weights are based on the joint distribution of disposable household income, homeownership status and age of the head of household as reported by Statistics Netherlands.

Table 2.10: Response to the reform, homeowners, head of household

	2010 Questionnaire	2012 Follow-up questionnaire	Difference of means test (p-value)
I will not respond to this reform	79.3%	68.1%	0.000
I will save more	4.1%	13.9%	0.000
Me or my partner will work more hours	0.1%	1.7%	0.003
I will postpone the purchase of a new house	1.7%	4.8%	0.002
I will move to a less expensive house	1.1%	0.08%	0.820
I will renegotiate my interest rate and fix it for a longer period of time	1.9%	3.1%	0.146
Other	6.9%	11.9%	0.001
Do not know	6.4%	2.1%	0.000
Observations	727	936	

Source: 2010 Questionnaire and 2012 Follow-up questionnaire. We use sample weights to make sure that the reported statistics are representative of the Dutch population age 25 and above. The sample weights are based on the joint distribution of disposable household income, homeownership status and age of the head of household as reported by Statistics Netherlands. Does not sum to a hundred percent because respondents may provide multiple answers.

Table 2.11: What will happen in 2013?

		Fall	Rise	Remain unchanged	don't know
All	House prices	67%	6.8%	18.5%	4.5%
	Uncertainty on the housing market	20.6%	39.0%	34.5%	5.9%
	Number of transactions	41.6%	20.9%	27.4%	10.4%
Owners	House prices	70.1%	5.2%	20.1%	4.6%
	Uncertainty on the housing market	21.1%	39.3%	35.8%	3.8%
	Amount of transactions	41.2%	22.3%	29.0%	7.4%
Tenants	House prices	62.9%	9.0%	16.3%	11.9%
	Uncertainty on the housing market	19.8%	38.7%	32.8%	8.8%
	Amount of transactions	41.3%	18.9%	25.3%	14.4%

Source: 2012 Follow-up questionnaire. (N=1319). We use sample weights to make sure that the reported statistics are representative of the Dutch population age 25 and above. The sample weights are based on the joint distribution of disposable household income, homeownership status and age of the head of the household as reported by Statistics Netherlands.

Chapter 3

Mortgage risks, debt literacy and financial advice

3.1 Introduction

Taking out a mortgage loan is not an easy decision. Households are faced with an extensive range of mortgage types, often with complicated features. Moreover, households have to take into account factors such as the tax system, expected house price developments, expected income growth, expected interest rate movements, with these expectations being subject to a great deal of uncertainty. There is little scope to learn from past experiences, as mortgage loans are taken out infrequently. At the same time, choosing a mortgage loan is an important decision with long-term financial consequences.

Given the complexity of the decision, it is important that households taking out mortgage loans have adequate financial knowledge or access to financial advice. Several recent studies, however, have suggested that financial knowledge of households is often limited and, arguably, insufficient to take out a mortgage loan without proper guidance (see Lusardi and Mitchell, 2007 and Van Rooij et al., 2011). That is why households may benefit from financial advice provided by a mortgage broker. Financial advice, however, does not necessarily result in better mortgage choices, especially if brokers receive commission fees from the lender. If commission fees are linked to mortgage size and type, intermediaries may have financial incentives to recommend mortgage

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loans that are not in the best interest of households. Households with limited financial sophistication, in particular if they are unaware of the commission structure, are prone to biased financial advice. There is relatively little empirical evidence about the impact – if any – of financial advice on mortgage choices.[1]

This chapter analyses the relationship between financial literacy and mortgage choice, and the role of financial advice. More specifically, it examines whether financially sophisticated and financially less sophisticated households have different perceptions of the risks posed by their mortgage loans, and whether the former take out different mortgages in comparison with households with less financial knowledge. In addition, the chapter examines whether households that seek advice from financial intermediaries take out mortgages with different features.

To this end, we designed a special questionnaire for the CentERpanel, a panel comprising more than 2,000 Dutch households that complete weekly Internet-based household surveys. Our survey was set up to collect information on mortgage risks, debt literacy and the role of financial advice in selecting a mortgage. More specifically, we explicitly measured the risks of a mortgage loan and the riskiness of different mortgage attributes as perceived by the borrower. The debt literacy questions in our survey focus on the understanding of characteristics of debt contracts such as mortgage loans. The debt literacy questions designed by Lusardi and Tufano (2015) are more specific and detailed than the "basic" financial literacy questions formulated by Lusardi and Mitchell (2007), with the latter measuring the knowledge about basic financial principles which are important to day-to-day financial decision-making. The basic financial literacy questions are important determinants of, for instance, retirement planning (as highlighted by Alessie et al., 2011) and stock market investments (as demonstrated by Van Rooij et al., 2011). However, adequate basic financial literacy in itself may be insufficient to make infrequent debt decisions, including decisions about mortgage loans, given that there is little scope to learn from past experience. Using both sets of literacy questions enabled us to assess which component of financial literacy influences mortgage choice.

There are several reasons why it is especially informative to examine these questions for the Netherlands. First, the mortgage market in the Netherlands is well-developed and innovative, with a wide range of non-traditional mortgage products on offer. Interest-only mortgages and endowment mortgages linked to a life insurance policy are very popular. Second, there is no requirement to make a down payment upon

[1] The theoretical implications of financial advice to unsophisticated households that are unaware of the financial adviser's role are well understood (see Inderst and Ottaviani, 2012). Gabaix and Laibson (2006) have theoretically demonstrated that financial companies benefit from offering complex mortgage terms to unsophisticated households. Woodward and Hall (2012) have provided suggestive empirical evidence that offering complex mortgages to unsophisticated households is profitable for mortgage brokers.

the purchase of a home. It is common practice, in particular among first-time buyers, to raise the loan amount to include transaction costs, including property transfer tax and notary fees. As a consequence, the mortgage loan amount often exceeds the underlying property value. Third, Dutch mortgage loans are "recourse" loans, as is the case in most other European countries and in some US states, which implies that the borrower is liable for any deficiency in the event of default. This transfers the risks in the mortgage contract to the borrower. Fourth, the Netherlands experienced a sharp rise in house prices starting in the early 1990s, followed by a strong fall since 2008 reaching its lowest level in mid 2013. With house prices continuing to rise, many households bought houses financed with large mortgage loans. Falling house prices and deteriorating labor market conditions in the aftermath of the financial crisis put these households at great financial risk.

Our main findings are: first, households demonstrate less knowledge of loan contracts than of basic financial concepts, suggesting that loans are complex products for consumers. Moreover, the debt literacy measure is better able to explain the variation in mortgage risks than the more general basic financial literacy measure. Second, homeowners associate the following loan characteristics with risky mortgages: high loan-to-value ratios, high loan-to-income ratios and complex features such as linked life insurance policies investing part of the loan payments in the stock market. Third, home owners with higher levels of debt literacy typically hold more risky mortgages. Financially less sophisticated homeowners are more likely to have traditional mortgages, including annuity-based and linear mortgages, with homeowners gradually repaying the loan principal. Fourth, homeowners considering themselves incapable of taking out a mortgage consult mortgage brokers more often. However, households with a limited understanding of loan contracts – and therefore potentially benefiting most from advice – did not seek financial advice from a mortgage broker more often than more sophisticated homeowners. Fifth, homeowners who had consulted mortgage brokers held more risky mortgages. This effect is more pronounced for homeowners with low levels of debt literacy.

These results highlight a number of policy implications for financial education and advice. Worldwide, there are many initiatives aimed at increasing financial knowledge and awareness. As a first implication, our findings suggest that initiatives should go beyond basic financial concepts and pay attention to the specifics of loan decisions. As mortgage decisions are complex, with far-reaching financial consequences, households had better be well equipped for these decisions. Second, given the crucial role of independent financial advice, incentives resulting from adviser compensation need to be aligned with the interests of consumers as it is difficult for consumers with limited financial sophistication to assess the quality of advice.

The remainder of the chapter is organized as follows. Section 3.2 motivates our research questions and discusses related literature on mortgage choices and financial literacy. Section 3.3 explains the features of the Dutch mortgage market. Section 3.4 describes the survey design. Section 3.5 and 3.6 discuss our measures of mortgage risks and financial literacy, respectively. Section 3.7 investigates the relation between financial literacy, mortgage choice, mortgage risks and financial advice. The final section concludes and discusses implications.

3.2 Motivation and related literature

The 2007–2008 financial crisis has shown that mortgage loan decisions can have a huge impact on the financial situation of a household. Currently, many households find themselves with mortgage loans that exceed the home value because of falling house prices. Others are struggling to make their mortgage payments due to a loss of earnings or other adverse events, such as divorce. Distressed households unable to pay their mortgage will ultimately default on the loan, requiring them to sell their home. The costs of default are particularly high in the case of foreclosure. In a forced sale scenario, houses are typically sold at a large discount.[2] If the property's selling price does not cover the full amount of the outstanding mortgage debt, the borrower may be liable for the shortfall, which then has to be paid from financial assets or future income.

In many US states, lenders commonly decide not to pursue any shortfall to reduce the length of the foreclosure process, mainly because this is prohibited or restricted by law. These so-called non-recourse loans give homeowners with negative housing equity an incentive to strategically default (see Ghent and Kudlyak, 2011). This resulted in many US mortgage defaults in the course of the 2007–2008 financial crisis, when house values fell and job losses pushed households into payment problems.[3] In most European countries (and some US states), mortgage loans are recourse loans, which means that the lender has the right to pursue the borrower to pay any shortfall. As a result, the financial risk of default is passed onto the borrower.[4]

Households with negative housing equity that fall behind on their mortgage payments may find themselves in serious financial problems, or even face bankruptcy. This stressful situation, which is difficult to overcome, might even have consequences beyond the

[2] Campbell et al. (2011) have found an average discount on the market value of 27% for the United States. In the Netherlands, a foreclosure sale, typically through a public auction, results on average in a discount of 20% (see CPB, 2009).

[3] Several empirical studies indicate that default behavior is driven by a combination of payment problems and negative equity (e.g. Elul et al., 2010; Gerardi et al., 2013b). Negative equity, in itself, does not always lead to defaults on non-recourse loans because of the high costs of moving, the reduced credit rating or the risk of being sued; see Guiso et al. (2013) for the determinants of strategic default.

[4] See for example ECB (2009) for a description of differences in housing finance between the United States and the euro area.

financial domain, including depression or other health problems (see Currie and Tekin, 2015). Against this background, it is important to investigate whether borrowers are aware of the risks of a mortgage loan.

Recent studies for the US highlight that default rates are high among borrowers with non-traditional mortgage loans (see Mayer et al., 2009; Demyanyk and Van Hemert, 2011; Amromin et al., 2011). These alternative mortgage products differ from traditional mortgages. Unlike traditional mortgages, they are characterized by low (initial) mortgage payments, and require limited or deferred repayment of the principal. Low mortgage payments make owner-occupied housing more affordable for households anticipating strong increases in future income or house prices. Moreover, in some countries, deferred repayment of the principal in combination with tax-deductible mortgage interest payments allows borrowers to reduce their tax burden. Hence, non-traditional mortgages may be beneficial for sophisticated borrowers; see Cocco (2013) for an overview of the benefits of non-traditional mortgage products. However, despite the complex nature of these mortgages, they can also be taken out by less sophisticated borrowers, who are not aware of the risks.

High-leverage loans entail both benefits and risks. Access to no-down-payment mortgage loans may increase household welfare as high-leverage mortgages enable young households to smooth consumption over the life cycle (see Ghent, 2015). Indeed, access to mortgage loans with low down payments enabled many households to raise mortgage finance in the run-up to the financial crisis. However, this loosening of mortgage standards contributed considerably to the rise in defaults after the onset of the crisis (see Corbae and Quintin, 2015).

In light of the US subprime mortgage crisis, several recent studies have examined the default behavior and financial sophistication of households taking out risky mortgage products. Gerardi et al. (2013a) have demonstrated that financially illiterate borrowers are more likely to default on their mortgage loans. However, they have found no evidence of higher default rates resulting from riskier mortgage terms, such as high loan values relative to income and house value or adjustable rate mortgages. They have suggested that borrowers with a lower level of financial literacy default more often after taking out the loan because of their inability to accumulate sufficient wealth to absorb income shocks, for example when macroeconomic shocks give rise to involuntary unemployment. Klapper et al. (2013) have documented that individuals with relative low financial literacy are indeed less able to deal with macroeconomic shocks.

Another potential channel through which financial literacy affects default is the inability to assess the affordability of the mortgage over the life of the loan, for example because of having incorrect expectations about income growth, investment returns or house price appreciation. Stafford et al. (2012) have shown that US households allocate

too much of their household income to mortgage payments in times when the labor market is performing well and house prices appreciate. On the other hand, Amromin et al. (2011) have suggested that a lower level of financial literacy might also increase the likelihood of default, because less sophisticated households may underestimate the costs of default such as reputation loss, penalty charges, or a lower credit rating. By contrast, for non-traditional mortgages, such as interest-only mortgages, Amromin et al. (2011) have found that more sophisticated borrowers (based on credit scores and income) are more likely to default on the mortgage loan, possibly because of strategic reasons. They have also shown that more sophisticated individuals are more likely to hold interest-only mortgages. This has also been found by Cox et al. (2014), who have studied the link between mortgage type choice and self-assessed financial knowledge among households in the Netherlands.[5]

Mortgage brokers[6] may provide financial advice and help households reach mortgage decisions. This can be particularly helpful for those who feel incapable of taking these decisions on their own. Conklin (2015) has indeed found that illiterate households who receive face-to-face advice have a lower probability of default. Investigating several explanations, Conklin has concluded that this positive correlation is due to mortgage brokers advising borrowers on their broad financial situation and explaining the features and consequences of mortgage loans. However, there is also an alternative view according to which mortgage brokers may extract additional income from illiterate consumers by advising suboptimal loans, e.g. with higher interest rates (see the literature overview in Conklin, 2015).

We contribute to this literature by explicitly measuring the riskiness of the mortgage loan and risk perception instead of analyzing default behavior (which might be unrelated to the "objective riskiness" of the mortgage loan). In addition, we examine the role of financial advice in mortgage choice. There is limited empirical literature on the role of financial advice in shaping consumer decisions, and it mainly focusses on investment decisions. Finally, we measure both the understanding of basic financial concepts, as well as the understanding of complex loan contracts.

[5]Interestingly, our results confirm that individuals who report a higher self-assessed financial knowledge own an interest-only mortgage more often. However, we were able to analyze the relation with objective knowledge and we do not find that having an interest-only mortgage is related to the actual level of financial literacy.

[6]When we use the term mortgage broker, we refer to traditional mortgage brokers and other financial intermediaries who bring together borrowers and lenders in the mortgage market and provide financial advice to households.

3.3 An outline of the Dutch mortgage market

The Netherlands has an extensive menu of residential mortgage types available compared with other countries. Over the years, several innovative mortgage types have been developed which take full advantage of the tax deductibility of mortgage interest. Mortgage interest payments are fully deductible at a maximum rate of 52% for persons in the highest tax bracket.[7]

The most common mortgage loan is an interest-only loan, on which the borrower pays interest without making principal repayments. The principal has to be repaid when the loan matures, usually after 30 years. As the outstanding mortgage balance does not change over the life of the mortgage, borrowers make maximum use of the tax deductibility of interest payments over the whole period. Another widely available mortgage type is the endowment mortgage, consisting of an interest-only mortgage which is linked to a savings account in the form of a universal life insurance policy. The borrower pays both interest and an insurance premium (part of) which is set aside to repay the principal after 30 years. The cash value of the savings accumulated under the life insurance policy is exempted from wealth taxation.[8] A related mortgage type concerns the investment-based mortgage, whose premium is invested in the stock market. Borrowers with investment-based mortgages run the risk of ending up with insufficient funds to repay the mortgage at maturity in the event of poor investment returns. Traditional fully amortizing mortgages – whose principal is gradually repaid based on a linear or annuity-based repayment scheme – are rare in the Netherlands because of the tax relief. The majority of mortgages are fixed rate mortgages (FRMs) with fixed terms ranging between five and ten years. A small fraction of the purchased mortgages have an adjustable rate (adjustable rate mortgage – ARM) closely linked to market interest rate developments.[9]

The combination of generous mortgage interest tax relief and relaxation of lending criteria by financial institutions in the second half of the 1990s encouraged households to take out large mortgage loans (see DNB, 2000). In principle, mortgage lenders require no down payment and transaction costs are typically included in the loan amount. Mortgage loans which exceed the property value are very common: mortgages with a loan-to-value (LTV) ratio between 110% and 115% were the norm until fairly recently. In 2010, there was no cap on mortgage loans as a percentage of the house value (see AFM, 2009). The typical LTV ratio is much lower in other countries. In the United

[7] The government has decided to gradually reduce the maximum deduction from 52% in 2013 to 38% in 2041. Many other countries with mortgage interest deduction changed their rules at an earlier stage; either by abolishing or significantly reducing mortgage interest tax relief.

[8] Endowment mortgages are also common in the United Kingdom. However, they are rare in other countries (see Devereux and Lanot, 2003).

[9] DNB Statistics (2010); available from: <http://www.statistics.dnb.nl>, [2 October 2014]

States, LTV ratios of about 75% are common, and they are even lower in countries such as the United Kingdom and Germany, with typical LTVs of about 70% (see Green and Wachter, 2005). As a consequence of the large mortgage loans and limited mortgage principal repayments, outstanding mortgage debt in the Netherlands amounts to 107% of GDP, versus 76.5% in the United States and less than 50% in Germany in 2012 (see EMA, 2012). In fact, the Netherlands is among the countries with the largest outstanding mortgage debt as a percentage of GDP in the world. Thus, borrowers are exposed to significant risk if house prices decline, which has been the case in recent years.[10]

Some borrowers have the option to take out a mortgage loan under the Dutch national mortgage guarantee (NMG) scheme, which protects both lenders and borrowers against losses upon default. The aim of the NMG scheme is to encourage home ownership.[11] Borrowers with a mortgage under the NMG scheme are protected against loss if default is related to a number of clearly defined liquidity shocks, for example owing to divorce, involuntary unemployment, or the death of a spouse. These borrowers are released from the obligation to repay the remaining debt (if they have insufficient housing equity or financial assets to repay the mortgage loan). The NMG scheme insures mortgages for houses up to a ceiling amount (EUR 290,000 in 2013). One of the conditions to qualify for a mortgage loan under the NMG scheme is that at least half of the value of the mortgage has to be fully amortizing. After paying a modest premium to buy NMG, borrowers with an NMG mortgage pay a slightly lower interest rate because the lender bears less risk.[12]

3.4 Data

3.4.1 The mortgage risks questionnaire

We designed a detailed questionnaire on mortgage risks, debt literacy and financial advice. The questionnaire was fielded in the CentERpanel in the weekend of 18 June 2010. The CentERpanel is an Internet-based panel of over 2,000 households administered by CentERdata at Tilburg University and sponsored by De Nederlandsche Bank. The panel is representative of the Dutch population. Panel members without Internet access receive a set-top box and equipment that enables them to participate through

[10] As a result, the Dutch government has implemented new measures to prevent disproportionately large mortgage loans. For example, a statutory LTV cap has been introduced, which will be gradually reduced from 106% in 2012 to 100% in 2018.

[11] While an NMG mortgage loan has similarities with FHA mortgages in the United States, the latter insure the lender only against default risk.

[12] NMG, Conditions and Norms of the National Mortgage Guarantee (in Dutch), available from: <http://www.nhg.nl>. [2 October 2014].

their television sets. Within each household, both the head and the partner aged 20 or older were interviewed. The questionnaire was presented to 2,184 household members of which 1,464 members (1,185 households) completed the survey, implying a response rate of 67% at the individual level. This corresponds with the response rates to the annual DNB Household Survey (DHS) modules, i.e. the main CentERpanel-based survey (see Teppa and Vis, 2012).

The rate of homeownership in our sample was 73.8% (874 households), with 85.6% of homeowners (748 households) having a residential mortgage loan on their property. This is somewhat higher than the ownership rate among Dutch households. We used sample weights to ensure that the reported statistics are representative of the Dutch population. The sample weights were based on the joint distribution of disposable household income, homeownership status and age of the head of the household as reported by Statistics Netherlands.[13]

The questionnaire on mortgage choice was combined with background information from the 2010 DHS. The DHS is an annual panel study which collects detailed information on wealth holdings, earnings, socio-demographic information and behavioral traits, such as risk preferences and time preferences, to study the determinants of saving behavior. The DHS consists of six modules. The module on accommodation and mortgages was completed in the same weekend as our questionnaire. This module had to be completed by the household member in charge of household finances (designated as the head of the household if both members participated in our questionnaire).[14] Combining our survey with the annual mortgage information resulted in an 80.4% match rate for households with a mortgage. The combined sample included 592 households (755 individuals) with a mortgage loan. For these households financial statistics about the mortgage loan were constructed, as described in the next section. We excluded from our analysis of mortgage choice all households with missing values or obvious reporting errors on important mortgage loan characteristics, reducing the sample size to 531 households (680 individuals).

We used two sets of literacy questions (one set measuring basic financial literacy and the other debt literacy) to assess whether financial literacy – and which component of financial literacy – is related to the features and riskiness of the mortgage loan. In addition, we asked individuals to assess their capability to take out a mortgage loan without financial advice. The financial literacy questions were fielded in a separate questionnaire one week before the questionnaire on mortgage risks. The financial literacy questions were answered by 91.1% of respondents in the mortgage risks survey. There

[13]For individual household members, the weighted sample statistics match the joint distribution of gross personal income, age and gender.

[14]We were able to retain some additional households by using information from adjacent years.

were 1,080 households (1,324 individuals) with non-missing information on financial literacy.[15] The final sample, which we used for the empirical analysis of mortgage risks and financial literacy, included 459 households owning a mortgage.

3.4.2 Mortgage characteristics

In line with the literature on mortgage default, we constructed several financial measures related to payment problems and mortgage default, for example as demonstrated by Cocco (2013). First, we calculated the original loan-to-value ratio (OLTV), defined as the ratio of the original loan amount to the purchase price of the house. The current loan-to-value ratio (CLTV) was defined as the ratio of the outstanding mortgage loan balance to the current self-reported house value.[16] For endowment mortgages and investment-based mortgages, we took into account the cash value of the savings account linked to the mortgage to repay the principal at maturity. We also created a dummy variable for households with LTV ratios exceeding 100%.

Second, to measure the financial burden of the loan, we computed the current payment-to-income ratio (CPTI) – i.e. the ratio of gross mortgage payments to net household income. We defined the current loan-to-net income ratio (CLTI) as the ratio of the current loan amount to disposable household income. We were able to retrieve disposable household income data for the year of home purchase only for households participating in the DHS in the year the house was purchased. This information was available for about 60% of the households in our sample that had purchased a house after 1993 (which is when the DHS started). For those households, we calculated the original loan-to-income ratio (OLTI).

Table 3.1 presents financial characteristics of the mortgage loans by age and by year of house purchase and year of mortgage origination. The data show an increasingly large share of property values being funded by mortgage loans over the last decade. For house purchases after 2007, the majority of the households took out mortgage loans exceeding the value of their properties. The number of households with original LTV ratios greater than 100% rose from 25.0% in the early 1990s to 67.3% for house purchases after 2007, with an average original LTV ratio of 103% for house purchases after 2007. Over the same period, the loan amount relative to the net household income

[15] We excluded from our sample six households that consistently answered "Do not know" to all basic financial literacy and debt literacy questions, as well as to other questions in the questionnaire. We established that this did not affect the empirical results.

[16] Some households have mortgages consisting of a combination of loans. A typical combination of loans is a mortgage with an interest-only component and a component in the form of an endowment mortgage or investment-based mortgage. In addition, some households take out second mortgages to extract equity, for example to finance home improvements. Our analysis was based on the combined loan amount. As regards the other characteristics, such as mortgage type, we used the characteristics of the first mortgage.

(at time of purchase of the house) also increased sharply. The average original LTI ratio increased from 6.2 between 1996 and 1999 to 9.1 after 2007. Large mortgage loans imply that homeowners have to allocate a large share of their household income to mortgage payments. The gross current payment-to-net income (PTI) ratio of mortgages taken out after 2007 stood at about 50%. The net current PTI ratio was lower owing to the impact of mortgage interest tax relief.

Mortgages with high LTV and LTI ratios were taken out principally by younger households. Households aged under 40 on average had an original LTV ratio of 103%; about 62% had original LTV ratios of more than 100%. Households aged 70 and older had an average original LTV ratio of 75%; only 11.8% had purchased their homes with a mortgage loan exceeding the property value. This is probably because existing homeowners are encouraged by tax rules to use positive housing equity for new house purchases, and because first-time homeowners are not required to make any down payment. Moreover, older homeowners are better able to make a down payment if they have accumulated financial assets over the course of their lives.

In many cases, the average current LTV ratio was lower than the original LTV ratio because of principal repayments or property price increases over the life of the loan. Nevertheless, about 23% of the households younger than 40 had negative equity in 2010. Households in this group also made large mortgage payments in proportion to total household income. It is doubtful whether they would be able to continue repaying their mortgage loans if household income fell, for instance because of job loss or divorce. The combination of negative equity and a significant payment burden puts these young households in a risky position. The price of owner-occupied houses declined on average by 15.9% between June 2010 and its lowest level in June 2013, according to Statistics Netherlands. The remaining mortgage debt of the older age groups was limited: fewer than 2% of households in the 50-59 age group – and virtually none of the retired households – had negative equity.

Table 3.2 shows the percentage of mortgage types by age and by year of house purchase and year of mortgage origination. Interest-only mortgages accounted for about 55% of all mortgages originated after 2007, with more traditional repayment mortgages, such as fully amortizing mortgages, accounting for only a small fraction. A large proportion of households in the sample held an endowment mortgage: about 35% of the mortgages taken out after 2007. Endowment mortgages were often taken out by younger households, with older households more often holding interest-only mortgages. The relative high prevalence of repayment mortgages among younger households – which have accumulated little housing equity – limits their risk of building up excessive debt.

Around the year 2000, many mortgages taken out were linked to investment vehicles because stock prices were soaring in those days, and expected stock market returns were

high. Investment-based mortgages became less popular after 2000 due to poor realized investment returns contributing to shortfalls in investment mortgages. After 2007, new investment-based mortgages declined to fewer than 3% of all new mortgage loans.

3.5 Measuring perceived mortgage risks

We are interested in the borrower's mortgage risks affecting the likelihood of delinquency and mortgage default and, therefore, the quality of the lender's mortgage loan portfolio. The borrower's risks associated with a mortgage contract can be classified into two important types. First, there is an "income risk" of being unable to meet mortgage payments, because household income declines or interest rates rise for ARMs. Second, there is a "wealth risk" of having a mortgage which exceeds the property value, because of house price declines, lending in excess of the property value, or a forced house sale at a discount – i.e. below the market value – after default.

Having negative housing equity is not necessarily problematic as long as there are no payment problems. In the event of payment problems – for example because of job loss or a divorce – the borrower may cut non-mortgage expenses or agree with the lender to temporarily suspend or reduce mortgage payments. If payment problems continue, the borrower will eventually be forced to sell the house or have the property go into foreclosure. Selling the house implies that the mortgage must be repaid. If the selling price is insufficient to repay the outstanding mortgage, the lender has the right to demand payment of any shortfall from the borrower since, under Dutch law, these are recourse loans.[17] Note that this is different for countries or US states with non-recourse mortgage loans. Having negative equity may prompt strategic defaults. Nevertheless, Bhutta et al. (2010) have documented that in recourse US states, too, defaults are mostly related to a double trigger, i.e. negative equity and a negative income shock. The median borrower does not strategically default before the negative home equity falls below 62% of the home value (see Bhutta et al., 2010).

Different mortgage contracts might balance the two sources of risk differently. The trade-off between income risk and wealth risk is described by Campbell and Cocco (2003). They have developed a theoretical framework for selection of conventional mortgage loans; Campbell and Cocco (2015) have provided a model that is also applicable to non-traditional mortgages, such as interest-only loans. Our survey therefore measured the borrower's perception of the "overall" riskiness of his own mortgage contract by asking the respondents to assess the overall riskiness on a four-point scale from 1 ("no

[17] NMG-insured borrowers are to a large extent protected against residual debt in case of involuntary default as described in Section 3.3, but there is no full coverage. The insured amount decreases as if the original mortgage is paid off according to an annuity mortgage.

risk") to 4 ("very risky").

In addition, we measured both sources of risk separately. The perceived risk of a payment problem (i.e. income risk) followed from a question relating to the respondents' ability to meet cost-of-living payments in the event of several adverse income shocks, such as temporary unemployment, divorce, or mortgage interest rate rises. The perceived risk of negative home equity (i.e. wealth risk) was measured by asking the respondents about their expectations regarding financial distress in the event case of a 20% drop in their home value. This drop approximates the actual decline in house prices in the years after completion of the questionnaire (between June 2010 and June 2013).

Table 3.3 presents the response frequency for the three questions on the perceived riskiness of the mortgage contract taken out by our sampled mortgage owners. Only a few mortgage owners considered their mortgage very risky (1.8%). The majority of borrowers described their loans as having hardly any risks (46.3%), while about a quarter characterized their mortgage loan as somewhat risky (27.0%), with one in five considering the loan not risky at all (21.2%). About one-third of mortgage owners stated their ability to meet their mortgage payments under any circumstances (31.4%), while almost two-thirds of borrowers expected to run into payment problems after an adverse income shock (64.6%). A significantly smaller group of borrowers were convinced that a drop in house prices would lead to serious financial problems (25.7%). This group's main concerns related to having insufficient funds to repay the mortgage at maturity and being unable to move because of negative home equity. A relatively small group of mortgage owners indicated that this would lead to immediate financial problems (16.9%).

Table 3.4 shows the relation between the perceived riskiness associated with the mortgage contract and the financial characteristics of the mortgage. The financial mortgage characteristics (e.g. the LTV and LTI ratios) were divided into three quantiles (low, intermediate, and high). We first investigated the link between the overall riskiness of the mortgage contract and financial mortgage characteristics. Because of the small size, the "very risky" group was combined with the "somewhat risky" group. Our results show plausible correlations between perceived risk and actual mortgage characteristics related to the LTV and LTI ratios, suggesting that mortgage owners do recognize important risk characteristics of their mortgage. For example, 42.4% of mortgage owners with a high current LTV considered their loan as risky, while just 9.6% of mortgage owners with a low LTV perceived their loan as risky. Our results reveal the same pattern for the other financial mortgage loan characteristics, such as the current loan amount in relation to net income (LTI) and mortgage payments in relation to net income (PTI). The association between the financial features of the mortgage loan and respectively

income risk and wealth risk is very similar.

Table 3.5 shows that the majority of respondents with an investment-based mortgage viewed their mortgage as risky (71.7%), while only 10.9% of respondents with a traditional amortization mortgage viewed their mortgage as risky. More common types of mortgages, such as endowment and interest-only mortgages, were typically viewed as hardly or not at all risky by homeowners with such mortgages. It seems that borrowers whose mortgage interest rates can change quickly (ARMs) did not consider their mortgages to be more risky compared with fixed-rate mortgages (FRMs). Borrowers with a National Mortgage Guarantee (NMG) did not consider their mortgages to be less or more risky than uninsured mortgages. However, borrowers with an NMG-secured loan were more certain than others that they could meet mortgage payments under any circumstances. This may be the result of strict affordability rules to qualify for NMG-secured loans. Finally, borrowers who consulted an intermediary were more likely to rate their mortgage as risky (not reported). We cannot infer a causal direction from this: consulting an intermediary might lead to higher risk awareness, and borrowers planning to take out a riskier mortgage may be more likely to ask advice from an intermediary.

3.6 Measuring financial literacy

3.6.1 Financial literacy

Do individuals who are financially less literate and may have a limited understanding of the features of a mortgage contract choose riskier mortgages? We assessed the respondents' understanding of basic economic principles such as interest rates, inflation and portfolio diversification using the three financial literacy questions developed by Lusardi and Mitchell (2007). These basic financial literacy questions have been extensively examined in a previous study on retirement planning by Alessie et al. (2011) using the same panel of households. We refer to these questions as "financial literacy" questions. The questions were worded as follows (with correct answers in bold):

1. Suppose you had EUR 100 in a savings account and the interest rate was 2% per year. After five years, how much do you think you would have in the account if you left the money to grow? **(i) More than EUR 102**, (ii) exactly EUR 102, (iii), less than EUR 102 or (iv) do not know.
2. Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After one year, how much would you be able to buy with the money in this account? (i) More than today, (ii) exactly the same, **(iii) less than today** or (iv) do not know.
3. Buying a single company's stock usually provides a safer return than a stock

mutual fund. True or false? (i) True, **(ii) false** or (iii) do not know.

Table 3.6 reports the responses to these questions. The first question was answered correctly by 90.7% of respondents, while 6.1% of respondents did not know the answer.[18] This score is higher than in the United States, where about 65% of respondents responded correctly and 13.5% did not know the answer (see Lusardi and Mitchell, 2011). However, we should be careful with comparisons between both sets of outcomes, because the questions were translated into a different language. Van Rooij et al. (2011) show that a small difference in the wording of literacy questions can have an influence on the answers by respondents. The second and third questions were answered correctly by 84.6% and 58.1% of respondents, respectively. The third question appeared the most difficult one, with 30.4% of respondents answering "Do not know".

The bottom panel of Table 3.6 shows the distribution of the number of correct answers. More than half of the respondents answered all three questions correctly. It thus seems that the majority had a good understanding of basic financial principles. Zooming in on specific skills, almost all respondents were able to do simple interest rate calculations, but many found it difficult to understand the basic principles of portfolio diversification and risk reduction.

3.6.2 Debt literacy

Given that a good understanding of the basic economic principles may not be sufficient to comprehend complex mortgages, our survey included a number of more specific questions to determine the respondents' understanding of debt contracts such as mortgages. In particular, we asked our respondents to answer the three questions developed by Lusardi and Tufano (2015). The authors refer to these questions as "debt literacy" questions since they measure knowledge about debt contracts, which is important when taking out a loan. Specifically, the debt literacy questions measure respondents' understanding of compound interest, the time value of money, and the ability to distinguish between different payment methods. The original questions focus mainly on credit card debt, which is common in the United States, but virtually non-existent in the Netherlands. We rephrased the questions slightly, referring to a personal loan extended by a bank rather than credit card debt. The questions were drafted as follows (with correct answers in bold):

1. Suppose you take out a EUR 1,000 personal loan from a bank and the interest rate you are charged is 20% per year compounded annually. If you did not pay anything off, at this interest rate, how many years would it take for the amount you owe to double? (i) 2 years, **(ii) less than 5 years**, (iii) 5 to 10 years, (iv)

[18] Respondents were also able to refuse answering the question, which they occasionally did. We considered these refusals as missing observations.

more than 10 years or (v) do not know.

2. Suppose you take out a EUR 3,000 personal loan from a bank. You repay a minimum amount of EUR 30 each month. At an annual percentage rate (APR) of 12% (or 1% per month), how many years would it take to clear your personal loan debt if you made no additional new charges? (i) less than 5 years, (ii) between 5 and 10 years, (iii) between 10 and 15 years, **(iv) continue to be in debt** or (v) do not know.
3. You purchase an appliance which costs EUR 1,000. To pay for this appliance, you are given the following two options: (a) Pay twelve monthly installments of EUR 100 each or (b) borrow at a 20% annual interest rate and pay back EUR 1,200 a year from now. Which is the more advantageous offer? (i) option (a), **(ii) option (b)**, (iii) they are the same or (iv) do not know.

The first panel of Table 3.6 presents the frequency of correct responses to these questions. The first two questions invited the respondents to calculate the impact of compounded interest on the outstanding loan amount and any reduction therein. At first sight, these questions are somewhat similar to the first financial literacy question. The debt literacy questions, however, refer to loan contracts instead of savings accounts. The specific context of the questions and the more advanced skills needed to answer them make them more complex. The proportion of correct answers to both questions is much lower in comparison with the basic literacy question on compound interest. The first and second debt literacy questions were answered correctly by 66.9% and 48.3% of respondents, respectively. The results differ somewhat from those for the United States as documented by Lusardi and Tufano (2015), who have reported that both the first and second questions are answered correctly by about one-third of the respondents.[19] The lower score for the United States is notable in light of the much greater experience with consumer debt, in particular credit card debt, and suggests that one's understanding of loans does not automatically improve with experience.[20]

The responses to the third debt literacy question show that the concept of the time value of money was poorly understood: only 12.1% of respondents answered correctly that it was advantageous to defer payment by one year. Table 3.7 provides the distribution of responses in the various answer categories for this question. About half of the respondents indicated that both payment schemes were similar, thereby overlooking the fact that one can earn interest by deferring payment. A relatively large proportion

[19] Disney and Gathergood (2013) have presented results for the United Kingdom that are comparable to those for the Netherlands with respect to the first two debt literacy questions. They do not use the final debt literacy question.

[20] Christelis et al. (2015) have shown that non-mortgage debt, such as consumer loans and credit card debt, is held by more than 60% of households in the United States, while the prevalence of consumer loans and credit card debt is around 40% in the Netherlands.

of respondents (about one-third) mistook the most expensive option for the most attractive choice. Respondents appear to be quite confident about their answers, as the percentage of "do not know" answers was relatively low (12.6%). Insufficient knowledge to answer the third question correctly has also been found by Lusardi and Tufano (2015) for the United States, with 7% of the sample providing the correct answer. Li et al. (2013) have found a very similar ranking with respect to respondents' performance on both the debt literacy and financial literacy questions, as in our sample.[21]

Only 8.6% of respondents answered all three debt literacy questions correctly, while 34.7% answered two questions correctly. The scores on the debt literacy questions indicate that while individuals may have been able to make simple interest calculations, they had difficulty in grasping more complex loan decisions.

The bottom panel of Table 3.6 shows the distribution of the number of correct answers to all six financial literacy questions combined. About 7% of individuals answered all six questions correctly, and about 25% of individuals had one incorrect answer, while more than 20% of the individuals answered more than half the questions incorrectly. Thus, there was considerable variation in the level of financial sophistication among individuals. This is helpful in analyzing the association between financial literacy and mortgage risks.

To get a better understanding of the high number of incorrect responses to the debt literacy questions, we examined whether individuals with good scores on the basic financial literacy questions had performed well on the more specific debt literacy questions, and vice versa. First, we compared the distribution of correct debt literacy answers conditional on the number of correct answers to the basic financial literacy question. Panel A of Table 3.7 shows that individuals with perfect scores on the basic literacy questions also performed much better on the debt literacy questions. More than half of the individuals with perfect scores on the basic financial literacy questions answered two or three debt literacy questions correctly, compared with only one-third for individuals with two correct basic financial literacy answers and 13.6% for respondents providing one correct basic literacy answer. The strong association between the number of correctly answered basic literacy questions and correctly answered debt literacy questions is confirmed by the Pearson chi-squared test statistic, which rejects the null hypothesis of no association between both variables.

Panel B of Table 3.7 shows a cross tabulation of the number of correctly answered financial literacy questions and the answers provided to the third debt literacy question about the time value of money, which was poorly understood. This question was

[21] Our empirical analysis included a sensitivity analysis in which we also attached weight to persons who had not given a completely wrong answer to the third debt literacy question, saying that both options were the same (i.e. answer category (iii)). This did not affect the results for the relationships between debt literacy and mortgage risks.

answered correctly by only 17.3% of respondents with a perfect score on the financial literacy questions. It thus seems that even individuals with a good understanding of basic financial concepts often overlook the fact that money earns interest. Financially literate persons are, however, less likely to give a completely wrong answer compared with individuals who are financially less capable. About 52.2% of individuals with a perfect basic financial literacy score indicated that both payment schemes were similar, and 27.8% mixed up the most expensive scheme and the most favorable payment scheme – which we considered to be a "completely wrong" answer. The number of respondents giving a completely wrong answer was much higher for financially less capable individuals, and the same applies to the proportion of "do not know" responses.

3.6.3 Debt literacy and personal characteristics

Table 3.8 shows the distribution of the number of correct debt literacy questions across socio-economic characteristics, revealing higher debt literacy scores for younger, higher educated, male or home owning respondents. Alessie et al. (2011) have reported similar results for the financial literacy questions. The Pearson chi-squared test statistics show that debt literacy differences among gender, age, education and homeownership are highly significant. As regards the relationship between age and debt literacy, we observed an inverted U-shaped pattern of the average number of correctly answered questions. This is consistent with the findings regarding actual credit loan decisions for the United States by Agarwal et al. (2009) and other studies on investment decisions.[22] While we cannot disentangle age and cohort effects based on these cross-sectional results, the typical interpretation of the higher literacy scores among middle-aged individuals (aged from 40 to 49 years) is that, compared with younger generations, they have greater debt experience, albeit with the number of correct answers falling as individuals grow older and cognition declines.

Having answered the three debt literacy questions, respondents were asked how many of these questions they felt they had answered correctly. 42% of respondents thought they had answered all three debt questions correctly. In fact, only 16% of this group provided a correct answer to all three questions (Table 3.9). While over 50% answered two questions correctly, three in ten answered no more than one question correctly. Thus, a sizeable group of respondents seem overconfident about their debt knowledge. At the same time, there is a smaller group of under-confident respondents, i.e. whose actual number of correct answers exceeds the perceived number of correct debt literacy answers.

Furthermore, we asked the survey participants to assess their financial knowledge in

[22] For example, Korniotis and Kumar (2011) have shown that the effect of cognitive decline on investment skills dominates the role of experience.

general and to assess their capability to take out a mortgage without financial advice.[23] There is a strong correlation between the self-assessed measures and the number of correct literacy questions and thus respondents seem, to a certain extent, to be aware of their general level of financial sophistication and skills in comparison with other people (Table 3.9). More than 20% of the individuals who considered themselves well capable to arrange a mortgage loan without financial advice had three correct debt literacy answers, while only 3% of the persons who stated their inability to take out a mortgage without advice had perfect scores on the debt literacy questions. We found a similar pattern with respect to self-assessed financial knowledge. More experienced home buyers have a better understanding of debt contracts than first-time homeowners, which is consistent with the increasing part of the inverted U-shaped relation of debt literacy with age.

3.6.4 Debt literacy and financial advice

Do less experienced homeowners or financially less sophisticated persons seek personal advice or do they use other sources of information to make a more informed mortgage choice? Table 3.10 presents the sources of information used by borrowers when purchasing a house. The majority of the sample considered the advice of the mortgage lender (49.4%) or an independent mortgage broker (54.4%) as the most important source of information when purchasing a house. Advice from family and friends (29.4%) or the Internet (27.4%) were other important sources of information. Individuals with more financial knowledge often used information from financial magazines and books (20.8%) or other published sources – such as newspapers (9.3%), brochures (11.2%) and the Internet (36.6%) – to acquire information rather than to rely on the advice of experts only. Thus financially sophisticated borrowers typically gather additional information before deciding on the best option, and do not rely on financial advisers only. As a result, financially capable borrowers are less prone to potential biased financial advice.

We did not find that individuals with lower debt literacy levels were more likely to consult a mortgage broker rather than buying a mortgage directly through a bank or lender.[24] Similarly, debt literate individuals showed no greater systematic tendency than less knowledgeable individuals to cite family or friends as an important source of information. Respondents who answered all debt literacy questions incorrectly mentioned family or friends the least often as an important source of advice (while respondents

[23] Self-assessed financial literacy was taken from the DHS module on Economic & Psychological concepts of saving.

[24] There is also no statistical evidence that borrowers with a lower debt literacy more often take out a mortgage through a financial intermediary. Regardless of the level of literacy, somewhat fewer than half of the mortgage owners took out their mortgages directly from the lender without the intervention of an intermediate broker or adviser.

who answered one question correctly most often stated the importance of advice of family and friends).

These findings differ from findings for other less complex financial decisions, such as investing in the stock market. Several studies have documented that for investment decisions, households with a higher level of financial literacy (see Van Rooij et al., 2011) or education (see Hackethal et al., 2012) are more likely to seek professional advice Van Rooij et al. (2011) have found that individuals with a lower level of financial literacy rely on family or friends more often as a source of information, while individuals with higher financial literacy more often rely on professional advice. Thus for mortgage choice, unlike other less complex financial decisions such as stock market participation, there is no systematic relationship between financial sophistication and advice sought from mortgage brokers or information obtained from family or friends. However, more sophisticated individuals use more sources of advice to make an informed decision.

By contrast, we found a strong relationship between the source of advice and the self-assessed capability to take out a mortgage without financial advice. Only one-third of the respondents considering themselves well able to take out a mortgage without advice relied on mortgage brokers, versus more than two-thirds of respondents lacking in confidence about their capability to take out a mortgage.[25] Similarly, respondents with a low self-reported capability to take out a mortgage were more likely to consult family or friends. This finding is confirmed by the former Financial Services Authority's (FSA) survey into the adequacy of information and advice among consumers who had recently purchased a financial product (see Finney and Kempson, 2008). The FSA survey has found that households with a low level of self-reported financial confidence are more likely to seek financial advice or consult family and friends compared with their confident counterpart.

3.7 Results on financial literacy and mortgage risks

3.7.1 Financial literacy and perceived risk of different mortgage terms

Are borrowers well aware of their mortgage risks? The perceived risk associated with the mortgage loan might not be consistent with the true underlying risk. Financially more sophisticated individuals or individuals taking out a mortgage through a mortgage broker may characterize their mortgages as more risky, not because their mortgages are more risky but simply because they are better informed about the risks. To examine this question, we asked the homeowners in our sample to rate the riskiness of six different

[25] Results are not reported but are available upon request.

mortgage features on a seven-point scale from 1 ("no risk at all") to 7 ("very risky"). The six features comprise short-term fixed interest rate, high loan-to-value ratio, substantial mortgage expenses in relation to household income, interest-only mortgage, investing part of the mortgage payments in the stock market and an adjustable rate mortgage (ARM).

The first column of Table 3.11 shows the average perceived riskiness of the different mortgage risk factors. Most mortgage owners perceived a high loan-to-value ratio, a high payment-to-income rate and having an investment-based mortgage as risky. The relatively low perceived risk associated with adjustable rate mortgages is consistent with the findings by Bucks and Pence (2008), who have shown that households underestimate the extent to which ARM rates can rise. The risk associated with investment-based mortgages can be considered as common knowledge given their wide media coverage and the fact that many of these products incurred large investment losses after the dotcom bubble burst in the years 2001 to 2003 and in the years after the fall of Lehman Brothers in September 2008. It is remarkable that having an interest-only mortgage was considered the least risky feature out of the six mortgage features surveyed, given that Dutch authorities have frequently stressed that such mortgages are risky. On the other hand, survey responses concerning house price expectations reveal that most borrowers were expecting house price increases at the time of the survey. Moreover, the risk of an interest-only mortgage is limited if individuals have substantial housing equity. Many households indeed indicated that a large drop in house prices would not lead to financial problems, because they had substantial housing equity (as discussed in the section 3.5 about measuring mortgage risks).

The next two columns of Table 3.11 show the association between financial literacy and the perceived riskiness of the different mortgage features. The reported coefficients were derived from ordered probit models with perceived riskiness as the dependent variable and the financial literacy measure as the independent variable. Socio-economic characteristics, experience of the housing market, and risk and time preferences were included as control variables.[26] The results show that more debt literate individuals consider a large mortgage loan in relation to the house value (LTV) (as well as high mortgage expenses) as more risky. The same holds for individuals with higher basic financial literacy. Moreover, individuals with higher debt or basic financial literacy consider investment-based mortgages to be more risky, though this association is in-

[26]To proxy for risk preferences, persons were asked to rate – from 1 ("risk averse") to 7 ("risk tolerant") – the statement: "I am prepared to take the risk of losing money, if there is also a chance to earn money." As an indicator of time preference, persons were asked to answer the question: "Which of the time horizons mentioned below does your household consider most important for planning expenditures and savings?" Answer category 1 corresponds to a short-term horizon and 5 corresponds to a long-term horizon of more than ten years from now.

significant for the debt literacy measure.

3.7.2 Financial literacy and features of the mortgage

Do differences in risk perception of mortgage features across different literacy levels go hand in hand with different mortgage products held by more and less literate mortgage owners? We performed a regression analysis to investigate any relationship between financial literacy and mortgage choices.

Table 3.12 shows the estimated coefficients of a linear regression for a number of mortgage features as the dependent variable and the financial literacy measure as the independent variable. The regression model contained the same control variables as before. Borrowers with higher levels of debt literacy took out mortgages with significant lower LTV and LTI ratios when they bought their homes. For basic financial literacy, we found that more literate borrowers had mortgages with significantly lower current LTV and current LTI values.

Table 3.13 shows the marginal effects from a multinomial regression model of the mortgage type on financial literacy. After controlling for socio-economic characteristics, expectations and risk and time preferences, we found that respondents with higher financial literacy were less likely to have traditional fully amortizing mortgages.[27] We did not find a relationship between financial literacy and having an ARM versus an FRM.

3.7.3 Financial literacy, mortgage risks and financial advice

Do individuals with lower financial literacy have riskier mortgages? To better understand the relation between financial literacy and the riskiness of the mortgage, we used the measure of overall riskiness of the mortgage contract. We have shown that this measure is strongly correlated with the risky features of a mortgage loan, such as the LTV ratio and the LTI ratio. This measure may, however, lead to biased results if the judgments about the riskiness of the own mortgage loan is not comparable across respondents. A lack of comparability between respondents results in measurement error, which may result in underestimation of the association between financial literacy and mortgage risks. To address this issue, we followed a two-step procedure. We first estimated an ordered probit regression on the self-reported overall riskiness of the mortgage contract as a function of objective "risky" features associated with the mortgage

[27] Similarly, respondents with a higher self-assessed capability to take out a mortgage (without financial advice) more often had interest-only mortgages, and were less likely to own endowment mortgages. Similarly, respondents with higher self-reported financial knowledge more often had interest-only mortgages, with traditional full amortization mortgages being less common among these respondents (results available upon request).

loan. We used the predicted risk from this regression to create an objective measure of individual risk of the mortgage loan, which we related to several measures of financial literacy in the second step.

Table 3.14 shows estimates of an ordered probit regression of the self-assessed risk of the mortgage loan. The dependent variable is coded 0 for "no risk at all", 1 for "hardly risky" and 2 for "somewhat (or very) risky". The first column shows the estimated coefficients for a specification which includes the financial features of the mortgage loan, but no information about the type of mortgage. Respondents with a higher current loan-to-value ratio or a higher mortgage payments to net-income ratio were more likely to consider their mortgage as risky. The second specification includes dummy variables for having an ARM and for the type of mortgage, with having an interest-only mortgage as the baseline. Respondents with an investment-based mortgage considered their mortgage more risky and respondents with traditional fully amortizing mortgages found their mortgages less risky (conditional on the financial features of the mortgage loan). Those with an ARM assessed their mortgages as more risky. We did not include a variable for having a mortgage which is insured under the NMG scheme, as this variable appeared to be insignificant in all specifications.

We used the estimates of the final specification to predict the mortgage risk based upon the features of the mortgage loan, which provides a more objective risk measure compared with homeowners' subjective risk perceptions of their own mortgages. Figure 3.1 shows the distribution of predicted mortgage risk for every household. We used this measure of mortgage riskiness as the dependent variable in a multivariate regression to test whether financial literacy is related to mortgage risks. The first part of Table 3.15 shows the regression coefficients for debt literacy. The first column shows debt literacy being positively associated with mortgage risk at the 1% significance level. The positive coefficient implies that individuals with a higher debt literacy have riskier mortgages. We find that one additional correct answered debt literacy questions is associated with a 0.127 standard deviations higher mortgage risk.

The coefficient of debt literacy declined after controlling for socio-economic characteristics, such as educational level, age, gender, marital status and having children, but remains significant (specification 2). Note that the significant debt literacy coefficients point to an association between literacy and having a risky mortgage. This finding does not necessarily imply a causal relation between literacy and risk taking. Indeed, this association could also stem from households becoming more literate as a result of taking out risky mortgages. However, regardless of the mechanism underlying this association, this finding suggests that owners of risky mortgages are not the most vulnerable households in terms of their financial literacy.

The next regression adds controls for mortgage advice (specification 3). Controlling

for sources of information in taking a mortgage, the regression estimates show that borrowers who received advice from a mortgage broker had riskier mortgages. Indeed, it makes sense for those who plan to take out a more risky loan with perhaps more complex features to consult an independent mortgage adviser. On the other hand, the Netherlands Authority for the Financial Markets (AFM) has recently introduced a ban on lender-paid commission fees owing to concerns about commission structures in which advisers get paid by lenders based on the mortgage amount and type of mortgage taken out.

We interacted the dummy variables for financial advice with the financial literacy measure. A significant coefficient for the interaction term suggests a differential effect of financial advice for households with different levels of financial literacy. The interacted variables were centered such that the coefficients on these variables could be interpreted as partial effects. The results show that financial advice resulted in riskier mortgages for less debt literate households (see Table 3.15, specification 3). Similarly, less-debt literate borrowers who emphasized the importance of mortgage advice from family and friends had riskier mortgages.

Next, the regression was extended by including the perceived riskiness of different mortgage loan terms, past experience in the housing market and risk and time preferences, and a measure for confidence.[28] In the previous subsection, financially more sophisticated individuals appeared to perceive several features of the mortgage loan as more risky, which may influence mortgage choice. We derived the measure of the overall perceived risk of a mortgage loan by performing a factor analysis of the perceived riskiness of the six different features of a mortgage loan. We included the first factor in the regression model. The results in specification 4 show that perceived mortgage risk is an important determinant of the riskiness of the actual mortgage loan. The positive coefficient implies that individuals have less risky mortgages if they perceive various features of a mortgage loan – such as a high loan-to-value ratio or an investment-based mortgage – as more risky. Respondents took out more risky mortgages if they had already moved to an owner-occupied house and thus had gained experience in taking out mortgages. The coefficients for risk and time preferences and confidence were insignificant. The inclusion of all these controls lowered the debt literacy coefficient somewhat, while the interaction term between literacy and financial advice saw no change in qualitative terms.

The final specification incorporates controls for income risk and wealth risk. The regression estimates show that individuals with risky mortgages expected to encounter

[28] Confidence was measured as the difference between the perceived and the actual number of correct debt literacy responses. A positive value denotes that respondents were overconfident about their debt knowledge, while a negative score reflects a lack of confidence.

financial problems more often should house prices decline or earnings losses occur.[29]

Table 3.16 shows the same set of estimation results for basic financial literacy. The first specification shows basic financial literacy also being positively correlated with mortgage risk. The effect of basic financial literacy on mortgage risk was not statistically significant. Thus, the literacy measure that explicitly zooms in on knowledge about debt appears to be a more accurate predictor of mortgage debt decisions than the overall measure of financial literacy. This is consistent with Gerardi et al. (2013b), who have found that numerical ability – the ability to perform "more advanced" computations – affects default behavior among US homeowners, while basic financial literacy is less important to default. Similarly, Disney and Gathergood (2013) have found that individuals who provide correct answers to debt literacy questions are less confused by financial concepts and more confident about financial decisions. At the same time, they have not found a strong significant relationship for the basic literacy question in their questionnaire.

3.8 Discussion

It is commonly known that a large group of households lack basic financial knowledge and do not possess the financial skills to take complex decisions (see Campbell, 2006). Our results highlight that the knowledge of basic financial concepts exceeds the level of knowledge of loan products, suggesting that debt decisions are particularly complex (see also Lusardi and Tufano, 2015). As basic financial knowledge alone is not sufficient to understand more complex products as loans, it is important that financial education initiatives set up by many governments include special modules or pay attention to the specifics of debt decisions.

A large number of countries witnessed housing busts in the aftermath of the financial crisis (including well developed countries with a highly educated population such as the United States, the United Kingdom, Spain, Ireland and the Netherlands), which has demonstrated how mortgage choices may result in a heavy financial burden. Mortgage owners became distressed because they could no longer meet their mortgage payments, or their debt exceeded the underlying value of their home. Our results show that, generally speaking, homeowners appear to be aware of the characteristics that increase the financial risks of a mortgage. Nevertheless, more knowledgeable households tend to take out mortgages with relatively higher risk levels, being aware of their exposure to income and wealth risk. In fact, financial literacy seems to be a blessing as well

[29] We performed a sensitivity analysis in which we also attach weight to persons who do not give a "completely wrong" answer to the third debt literacy question (i.e. answer category (iii)). This did not alter the results.

as a curse. It helps individuals in entering the stock market and planning for retirement, but it also encourages households to choose mortgages with risky characteristics that have put a lot of households in distress. Moreover, these developments negatively impacted consumption at macro level and deepened the economic downturn as households reduced their expenditure in the face of difficulties in meeting their mortgage payments or anxiety about negative housing equity. Given the complex nature of loan decisions, many households seek the help of a mortgage broker or base their decisions on other sources of information. Homeowners with more financial knowledge typically consult a larger number of information sources (e.g. financial magazines, newspapers and the Internet). While financially illiterate homeowners may be expected to consult a mortgage broker more often, this does not appear to be the case in practice. This is consistent with the argument that financial advisers are used by those who need them the least (see Hackethal et al., 2012). However, our results show that homeowners who consult advisers have more risky mortgages, regardless of their level of literacy (high or low). Nevertheless, the impact of advisers on the riskiness of the mortgage loan is less pronounced for the more literate consumers. We are not able to address the issue of causality, given that those homeowners planning to take out a more risky mortgage may have been the ones seeking advice from an adviser. However, the results highlight the importance of independent financial advice and a commission structure without incentives to advise risky mortgages when they are less suitable.

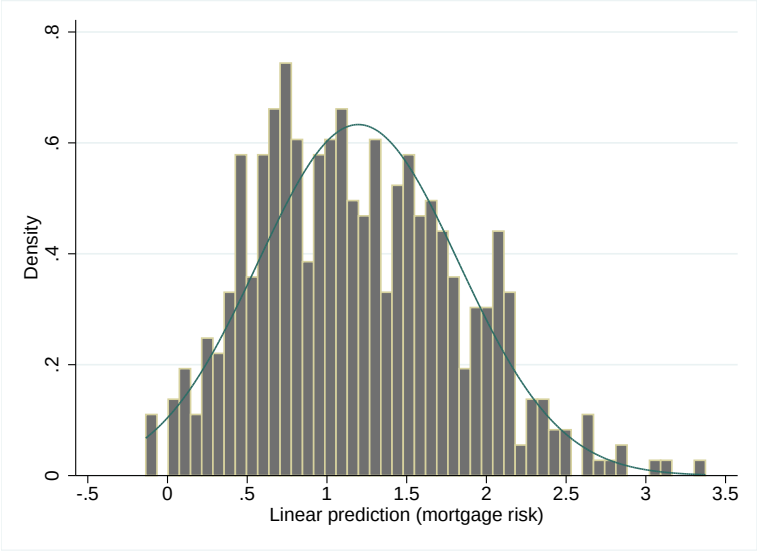
That is why several countries have changed the legal rules for fee structures in the financial advice market. In the Netherlands, for instance, commission fee payments to intermediaries for the origination of mortgages have been banned since January 2013.[30] Consumers now have to pay the adviser directly for all services. This type of commission structure reduces concerns about mortgage advisers having incentives to give advice that goes against the interest of the consumer; see also Inderst and Ottaviani (2012) and Gorter (2012) for a discussion about how effective a ban on commission fees is when it comes to selecting financial products. This may result in more conservative mortgages being recommended and taken out, and, thus, fewer households with financial problems. On the other hand, high brokerage fees may discourage homeowners from obtaining financial advice. Although it is not clear beforehand whether homeowners will display the same behavior in the new setting, it is somewhat comforting that the results suggest that consumers with low literacy levels who do not consult financial advisers tend to take out less complex and more conservative mortgages.[31]

[30] At the same time, the government has introduced a number of measures to reduce the risk level of new mortgages, including a tax system that strongly encourages annuity-based or linear mortgages and an LTV ratio cap of 105% in 2013, which will gradually be reduced to 100% in 2018.

[31] As a remedy, policymakers may consider making financial advice mandatory for unsophisticated households or for households who plan to take out a risky mortgage product. However, the first

3.9 Tables and figures

Figure 3.1: Distribution of predicted mortgage risk on the basis of the mortgage loan features



The Figure shows a histogram describing the predicted mortgage risk. A normal density function is plotted in the graph.

empirical evidence shows that making financial advice mandatory does not influence the financial behavior of less sophisticated households (see Hung and Yoong, 2013), while it discourages households willing to avoid mandatory advice from taking out risky mortgages (see Agarwal et al., 2014). Although, overall, this would be helpful in reducing mortgage risks to homeowners, it would put a burden on those homeowners who are quite capable of taking a mortgage decision on their own.

Table 3.1: Financial mortgage loan features across mortgage loan durations and age groups

		LTV ratio		LTV ratio > 100%		LTI ratio		
	N	OLTV	CLTV	OLTV	CLTV	OLTI	CLTI	CPTI
Panel A. Year of house purchase								
After 2007	44	1.03	0.85	67.3	25.2	9.08	5.89	0.57
2004 to 2007	98	0.96	0.81	53.0	16.8	8.88	5.72	0.51
2000 to 2003	63	0.90	0.67	41.5	5.90	5.60	4.04	0.39
1996 to 1999	69	0.92	0.49	43.1	0	6.23	3.31	0.35
1990 to 1995	91	0.94	0.36	25.0	1.81	.	2.35	0.27
Before 1990	166	0.87	0.28	17.5	0.47	.	2.42	0.26
Panel B. Year the mortgage was taken out								
After 2007	61	1.00	0.77	57.1	19.6	9.18	5.21	0.49
2004 to 2007	167	0.97	0.72	47.6	12.6	8.63	5.07	0.46
2000 to 2003	82	0.90	0.55	35.5	3.34	4.93	3.60	0.34
1996 to 1999	82	0.89	0.43	34.6	0	6.64	3.03	0.34
1990 to 1995	61	0.91	0.28	19.4	0	.	1.78	0.25
Before 1990	78	0.82	0.21	15.6	1.06	.	1.88	0.24
Panel C. Age groups (household head)								
Above age 70	72	0.75	0.26	11.8	0	6.01	2.36	0.23
Age 60 to 69	126	0.87	0.40	22.9	0.59	6.39	3.10	0.32
Age 50 to 59	136	0.89	0.45	30.4	1.24	6.13	3.20	0.33
Age 40 to 49	107	0.97	0.61	45.4	6.65	9.06	4.14	0.43
Below age 40	90	1.03	0.82	62.1	22.6	8.81	5.23	0.47
Mean		0.93	0.55	38.1	7.30	7.97	3.80	0.38

Notes: (N=531). Panel A displays the average value of the mortgage measures by year of house purchase (for the head of the household). The construction and definition of these measures is described in Section 3.4.2. For the variable OLTI, the number of observations is lower because income data for the time period in which the mortgage was taken out were not available for all households (N=170). Panel B provides the same statistics by year of purchase of the current (first) mortgage. This period is different from the year of house purchase if the original mortgage is refinanced. Panel C displays the mean value of financial characteristics of the mortgage loan for different age groups. The statistics are weighted averages.

Table 3.2: Mortgage types across mortgage loan durations and age groups

	N	Mortgage type (percent)					ARM	Refinanced
		Full amortization	Endowment	Interest-only	Investment based	Other		
Panel A. Year of house purchase								
After 2007	44	1.15	41.5	45.8	3.32	8.21	6.97	4.73
2004 to 2007	98	4.77	32.4	45.8	8.66	8.35	1.60	6.21
2000 to 2003	63	4.85	22.5	45.7	22.1	4.86	12.2	30.8
1996 to 1999	69	1.27	45.4	34.8	17.6	0.82	4.78	28.3
1990 to 1995	91	11.6	36.5	40.9	11.1	0	11.7	38.5
Before 1990	166	18.4	18.2	56.9	5.88	0.71	15.0	65.4
Panel B. Year the mortgage was taken out								
After 2007	61	1.93	35.1	54.9	2.59	5.50	8.75	26.5
2004 to 2007	167	3.43	25.0	53.5	10.4	7.70	5.68	39.6
2000 to 2003	82	7.56	20.5	48.2	22.6	1.13	12.9	38.3
1996 to 1999	82	3.18	35.6	43.4	17.1	0.72	5.19	37.1
1990 to 1995	61	12.1	54.0	29.0	4.86	0	5.82	14.8
Before 1990	78	35.7	28.9	32.9	2.54	0	22.2	21.7
Panel C. Age groups (household head)								
Above age 70	72	19.7	2.34	77.2	0.78	0	13.1	45.1
Age 60 to 69	126	13.4	9.90	67.5	8.62	0.59	9.55	47.4
Age 50 to 59	136	7.72	29.4	47.7	12.8	2.40	15.1	37.6
Age 40 to 49	107	4.16	42.5	35.2	14.6	3.55	5.52	25.3
Below age 40	90	4.54	50.9	24.9	11.1	8.48	3.87	16.7
Mean		8.41	31.1	46.1	10.8	3.52	8.97	32.5

Notes: (N=531). Panel A displays the percentage of households that took out a type of mortgage by year of house purchase (for the head of the household). The five mortgage types are mutually exclusive and refer to the first mortgage. A description of the different mortgage types is given in Section 3.3. The final two columns of panel A report the average share of households with adjustable rate mortgages (ARMs) and that of households with refinanced mortgages, respectively. "Refinanced" is defined as households taking out a mortgage sometime after the house purchase. The same statistics are reported by year of origination of the current mortgage (panel B) and across five age groups (panel C). The statistics are weighted averages.

Table 3.3: Response frequency regarding the perceived riskiness of the own mortgage contract

Overall riskiness (of the mortgage contract)	Very risky	Somewhat risky	Hardly any risk	No risk	Do not know
	1.8	27.0	46.3	21.2	3.7
Income risk - Difficult to pay mortgage expenses under adverse unforeseen circumstances?	Yes	No			Do not know
	64.6	31.4			4.1
Wealth risk - Financial problems after a large house price decline?	Yes	No			Do not know
	25.7	62.9			11.4
No financial problems[a]					
Substantial equity in my house	86.2				
Sufficient net worth to absorb the losses	20.8				
Financial problems[a]					
Insufficient funds to pay off the mortgage at maturity	57.4				
Results in inadequate savings to support retirement	11.2				
Results in financial strain	16.9				
Unable to move to another house	27.6				
Other	4.5				

Notes: (N=930). The questions were asked to all household members with a residential mortgage on their property (748 households). There were 97 missing observations for the question regarding income risk, as these individuals did not participate in the DHS module on Accommodation and Mortgages. The statistics are weighted averages. [a] Does not add up to 100%, because respondents may provide multiple answers.

Table 3.4: Perceived riskiness of the mortgage contract versus financial characteristics of the mortgage

		Overall riskiness			Income risk		Wealth risk	
	Mean	Some-what risky	Hardly any risk	No risk	Yes	No	Yes	No
Current LTV								
Low	0.16	9.6	45.9	44.5	36.3	63.7	6.9	93.1
Intermediate	0.46	29.7	49.3	21.0	67.0	33.0	14.2	85.8
High	0.91	42.4	48.1	9.5	87.7	12.3	52.2	47.8
Pearson χ^2 test:		p-value = 0.00			p-value = 0.00		p-value = 0.00	
Current LTI								
Low	1.25	8.2	50.1	41.7	41.6	58.4	7.8	92.2
Intermediate	3.24	32.4	46.7	20.9	64.8	35.2	17.5	82.5
High	6.57	42.0	47.4	10.7	87.0	13.0	51.8	48.2
Pearson χ^2 test:		p-value = 0.00			p-value = 0.00		p-value = 0.00	
Current PTI								
Low	0.14	12.1	50.6	37.3	44.5	55.5	10.3	89.7
Intermediate	0.32	25.7	52.2	22.2	67.5	32.5	26.3	73.7
High	0.63	44.4	42.6	13.0	82.7	17.3	41.5	58.5
Pearson χ^2 test:		p-value = 0.00			p-value = 0.00		p-value = 0.00	

Notes: (N=680). The construction and definition of these measures is described in Section 3.4.2. The measures are reported for the members of the households for which all mortgage characteristics are available. The first column presents per quantile the average value of the financial measures of the mortgage. The other columns contain percentages. For every risk measure we considered the few "Do not know" answers as missing observations. The statistics are weighted averages.

Table 3.5: Perceived riskiness of the mortgage contract versus features of the mortgage

		Overall riskiness			Income risk		Wealth risk	
	Mean	Somewhat risky	Hardly any risk	No risk	Yes	No	Yes	No
Mortgage type								
Full amortization	9.1	10.9	36.5	52.5	54.1	45.9	15.0	85.0
Endowment	30.9	22.5	60.2	17.3	77.7	22.3	31.3	68.7
Interest only	45.4	28.0	47.0	25.0	58.8	41.2	24.5	75.5
Investment	10.2	71.7	21.6	6.6	80.5	19.5	33.2	66.8
Other mortgage	4.5	35.7	53.1	11.2	80.5	19.5	53.8	46.2
Pearson χ^2 test:		p-value = 0.00			p-value = 0.00		p-value = 0.04	
Adjustable rate mortgage (ARM)								
No	91.9	29.2	48.5	22.3	67.9	32.1	28.0	72.0
Yes	8.2	34.0	41.0	25.0	61.7	38.3	26.9	73.1
Pearson χ^2 test:		p-value = 0.62			p-value = 0.38		p-value = 0.87	
National Mortgage Guarantee (NMG)								
No	66.8	30.1	45.3	24.6	64.6	35.4	26.0	74.0
Yes	33.2	28.6	53.1	18.4	73.2	26.8	31.9	68.1
Pearson χ^2 test:		p-value = 0.21			p-value = 0.05		p-value = 0.21	

Notes: (N=680). The mortgage contract features are reported for the members of the households for which all mortgage characteristics are available. The first column presents the frequency for each mortgage type or category. The other columns contain percentages. A description of the different mortgage types is given in Section 3.3. For every risk measure we considered the few "Do not know" answers as missing observations. The statistics are weighted averages.

Table 3.6: Percentage of correct and incorrect basic financial literacy and debt literacy answers

Panel A. Percentage of correct answers								
	Debt literacy questions			Fin. literacy questions				
	1	2	3	1	2	3		
Correct	66.9	48.3	12.1	90.7	84.6	58.1		
Incorrect	21.0	35.7	76.7	3.2	6.0	11.5		
Do not know	12.1	16.0	11.2	6.1	9.4	30.4		
Panel B. Number of correct answers								
	None	1	2	3	4	5	6	Mean
Financial literacy	6.1	6.9	34.6	52.5	.	.	.	2.3
Debt literacy	24.6	32.1	34.7	8.6	.	.	.	1.3
Debt & financial literacy	4.9	4.2	12.7	19.9	25.8	25.2	7.3	3.6

Notes: The first part of Panel A shows weighted percentages of correct debt literacy answers for all questionnaire respondents (N=1,465). The final three columns report the distribution of answers to the basic financial literacy questions included in a separate module. This module was answered by more than 90 percent of our sample (N=1,324). Panel B displays the weighted number of correct answers for both modules and all six questions combined (N=1,324). The statistics are weighted averages.

Table 3.7: Debt literacy versus financial literacy

	Number of correct basic financial literacy answers				
	None	1	2	All	Mean
Panel A. Number of correct debt literacy answers					
None (n=353)	80.6	47.2	28.3	12.1	1.72
1 (n=442)	15.3	39.2	36.4	29.7	2.35
2 (n=430)	4.1	13.6	29.6	44.4	2.63
All (n=99)	0.0	0.0	5.6	13.9	2.79
Pearson χ^2 statistic: $F(8.76, 11595.1) = 22.76$, p-value = 0.00					
Panel B. Answers to third debt literacy question					
Option (a) (n=407)	13.8	41.4	31.9	27.8	2.34
Option (b) (n=145)	0.0	1.4	9.5	17.3	2.72
They are the same (n=625)	15.0	39.0	47.5	52.2	2.48
Do not know (n=147)	71.2	18.2	11.0	2.7	1.21

Notes: (N=1,324). The statistics are weighted averages. The Pearson chi-squared statistic were corrected for the use of sample weights via the correction of Rao and Scott (1984). The statistic is converted to an F statistic to get a valid p-value.

Table 3.8: Debt literacy and demographics

	Number of correct debt literacy answers				
	None	1	2	All	Mean
Age classes					
Age 70 and older (n=249)	42.4	35.5	18.8	3.3	0.83
Age 60 to 69 (n=362)	27.1	32.9	33.0	7.0	1.20
Age 50 to 59 (n=353)	21.2	30.0	41.0	7.7	1.35
Age 40 to 49 (n=261)	19.2	30.2	37.1	13.5	1.45
Below age 40 (n=240)	19.2	32.9	38.3	9.6	1.38
Pearson χ^2 statistic: $F(11.01, 16124.0) = 4.86$, p-value = 0.00					
Gender					
Male (n=788)	18.7	29.3	37.9	14.0	1.47
Female (n=677)	30.7	35.1	31.3	2.9	1.06
Pearson χ^2 statistic: $F(2.97, 4352.0) = 19.1583$, p-value = 0.00					
Education level					
Master's degree (n=197)	5.9	24.0	51.4	18.7	1.83
Bachelor's degree (n=408)	18.3	29.2	41.2	11.3	1.45
Secondary school (n=404)	26.2	36.5	32.0	5.3	1.16
Primary school (n=456)	41.4	36.2	19.9	2.5	0.84
Pearson χ^2 statistic: $F(8.79, 12870.9) = 16.0531$, p-value = 0.00					
Homeownership status					
Tenant (n=374)	33.3	37.9	24.3	4.5	1.00
Homeowner (n=1,091)	21.5	30.1	38.4	10.0	1.37
Pearson χ^2 statistic: $F(2.93, 4289.1) = 10.3986$, p-value = 0.00					

Notes: (N=1,465). The statistics are weighted averages. The Pearson chi-squared statistic were corrected for the use of sample weights via the correction of Rao and Scott (1984). The statistic was converted to an F statistic to get a valid p-value.

Table 3.9: Debt literacy versus self-assessed knowledge and experience

	Number of correct debt literacy answers				
	None	1	2	All	Mean
Perceived number of correct debt literacy answers					
None (n=162)	85.3	11.4	3.2	0.0	0.18
1 (n=223)	42.6	47.8	8.7	0.8	0.68
2 (n=464)	20.9	41.8	32.8	4.5	1.21
All (n=616)	6.5	24.6	52.7	16.2	1.79
	Pearson χ^2 statistic: $F(8.54, 12508.3) = 50.80$, p-value = 0.00				
Self-assessed financial knowledge					
Very knowledgeable (n=40)	17.0	18.0	40.9	24.2	1.72
Knowledgeable (n=291)	15.3	28.5	38.9	17.2	1.58
More or less knowledgeable (n=808)	24.8	34.1	34.7	6.5	1.23
Not knowledgeable (n=268)	33.1	32.5	31.5	2.8	1.04
	Pearson χ^2 statistic: $F(11.61, 16998.9) = 4.97$, p-value = 0.00				
Self-assessed capability to take out a mortgage without advice					
Well able (n=171)	13.4	18.4	46.5	21.7	1.76
Able (n=316)	16.6	27.1	45.4	10.9	1.51
More or less able (n=298)	18.9	37.1	34.1	9.9	1.35
Poorly able (n=314)	24.5	33.5	37.5	4.5	1.22
Not able (n=133)	34.2	37.5	25.3	3.0	0.97
Do not know (n=51)	60.8	23.0	12.8	3.4	0.59
	Pearson χ^2 statistic: $F(17.12, 25067.7) = 7.55$, p-value = 0.00				
Number of house moves to an owner-occupied house					
Never (n=346)	33.5	37.1	24.5	4.8	1.01
1 time (n=561)	24.1	34.1	32.6	9.3	1.27
2 times (n=364)	21.1	26.7	42.0	10.2	1.41
3 times (n=129)	16.8	31.5	39.7	12.0	1.47
4 times or more (n=65)	13.8	20.3	59.0	6.9	1.59
	Pearson χ^2 statistic: $F(11.59, 16961.8) = 3.93$, p-value = 0.00				

Notes: (N=1,465). There were 182 missing observations for the ability to take out a mortgage without financial advice as this question was not asked of individuals who lived in rental homes and reported that buying a house was not being considered (i.e. they strictly preferred to rent). There were 58 missing observations for self-assessed financial knowledge as these individuals did not participate in the DHS module on Economic & Psychological concepts of saving. The statistics are weighted averages. The Pearson chi-squared statistic was corrected for the use of sample weights.

Table 3.10: Financial advice versus debt literacy

	Number of correct answers					
	None	1	2	All	Total	*p*-value
What is your most important source of advice when purchasing a house?						
Parents, friends or acquaintances	22.5	33.2	31.4	25.4	29.4	0.24
Information from newspapers	2.1	2.8	3.4	9.3	3.5	0.00
Financial magazines, guides, books	6.9	9.3	16.0	20.8	12.3	0.00
Brochures from my bank or mortgage adviser	6.4	7.7	7.3	11.2	7.6	0.99
Bank or other institution that provides the mortgage loan	41.7	49.5	55.3	43.4	49.4	0.27
Mortgage broker	46.6	56.3	58.2	51.8	54.4	0.28
Advertisements on TV or in other media	0.7	0.4	0.5	0.0	0.5	0.50
Financial computer programs	4.0	4.0	5.5	10.4	5.1	0.08
Financial information on the Internet	15.2	22.7	36.3	36.6	27.4	0.00
Other sources	5.1	4.3	6.2	8.0	5.5	0.22
Do not know	13.4	3.8	0.7	1.4	4.5	0.00

Notes: (N=1,283). The table reports the percentage of individuals who attach importance to a specific source of information when purchasing a house stratified by the number of correct debt literacy answers. The percentages do not add up to 100%, because persons indicated multiple sources as important. The final column reports the *p*-values of a Pearson χ^2 test. The *p*-values have been adjusted to take into account that multiple tests are being conducted (Holm, 1979). This question was not asked of tenants without plans to purchase a house in the future (182 individuals).

Table 3.11: Financial literacy and perceived riskiness of different mortgage loan features: regression results

	Mean / SD	Debt literacy	Basic financial literacy
Short fixed term	4.87	-0.029	-0.075
	(1.60)	(0.039)	(0.051)
High loan-to-value ratio	6.20	0.078*	0.129**
	(1.16)	(0.044)	(0.058)
High mortgage expenses	5.98	0.127***	0.074
	(1.20)	(0.042)	(0.054)
Interest-only mortgage	4.18	-0.060	-0.059
	(1.59)	(0.038)	(0.046)
Investment-based mortgage	5.78	0.051	0.115**
	(1.34)	(0.042)	(0.057)
Adjustable rate mortgage (ARM)	5.00	-0.051	-0.008
	(1.36)	(0.039)	(0.051)

Notes: (N=1100). The first column shows the average perceived riskiness of different features of a mortgage loan. The perceived riskiness of a mortgage feature was answered on a response scale from 1 ("no risk at all") to 7 ("very risky"). The remaining columns of the table show the association between financial literacy and perceived riskiness of different features of the mortgage loan. The coefficient was derived from an ordered probit model using the perceived riskiness as the dependent variable and the financial literacy measure as the independent variable. The financial literacy measure was based on the number of correct answers.
The control variables included: marital status, gender, age group, education level, monthly household income (quartiles), homeownership status, having children, employment status, risk and time preferences, and number of house moves to an owner-occupied house.
Clustered standard errors (at the household level) are shown in parentheses.
Significant at the *** 1%; ** 5%; * 10% level.

Table 3.12: Financial literacy and financial mortgage attributes: regression results

	Debt literacy	Basic financial literacy
Current LTV	0.007	-0.035**
	(0.013)	(0.015)
Current LTI	0.080	-0.247*
	(0.105)	(0.141)
Current PTI	0.012	-0.014
	(0.010)	(0.014)
Original LTV	-0.033*	-0.019
	(0.017)	(0.021)
Original LTI	-0.647*	-0.217
	(0.378)	(0.453)

Notes: N=517.
The table shows the association between financial literacy and several mortgage loan features. The correlation coefficient was derived from an OLS regression using the mortgage feature as the dependent variable and the financial literacy measure as the independent variable. Controls: see Table 3.11. Standard errors are shown in parentheses.
Significant at the *** 1%; ** 5%; * 10% level.

Table 3.13: Financial literacy and mortgage type: regression results

	Debt literacy	Basic financial literacy
Full amortization	-0.026*	-0.037**
	(0.014)	(0.015)
Endowment	0.016	-0.008
	(0.021)	(0.026)
Interest-only	0.012	0.046
	(0.024)	(0.030)
Investment-based	0.001	0.004
	(0.014)	(0.019)
Adjustable rate mortgage (ARM)	0.013	-0.025
	(0.015)	(0.021)

Notes: N=517. The table shows the association between financial literacy and several features of the mortgage loan. The correlation coefficient was derived from an OLS regression (ARM) and a multinomial logit regression (mortgage type) using the mortgage feature as the dependent variable and the financial literacy measure as the independent variable (the marginal effects are reported). Controls: see Table 3.11. Standard errors are shown in parentheses.
Significant at the *** 1%; ** 5%; * 10% level.

Table 3.14: Riskiness of mortgage loan: regression results

	[1]	[2]
Current loan-to-value (LTV)	1.023***	1.020***
	(0.234)	(0.247)
Current payment-to-net income (PTI)	0.851***	0.804***
	(0.282)	(0.297)
Endowment mortgage		-0.007
		(0.133)
Other mortgage		-0.201
		(0.333)
Full amortization		-0.245
		(0.206)
Investment-based mortgage		1.090***
		(0.216)
Adjustable rate mortgage (ARM)		0.432**
		(0.198)
Threshold Parameters		
μ_1 (no risk at all to hardly risky)	-0.387**	-0.548***
	(0.156)	(0.169)
μ_2 (hardly risky to somewhat (or very) risky)	1.082***	0.998***
	(0.160)	(0.172)
Pseudo R-squared	0.09	0.13

Notes: (N=459). The table reports the regression coefficients from an ordered probit model with the perceived riskiness of the own mortgage loan as the dependent variable, using a three-point response scale: 0 ("no risk at all"), 1 ("hardly risky") and 2 ("somewhat (or very) risky"). The second column of the table includes indicators per type of mortgage (except for interest-only mortgages) and an indicator for having an ARM versus an FRM. The investment-based mortgage type was interacted with the financial characteristics of the mortgage (i.e. LTV ratio and PTI ratio). Both specifications include controls for the year in which the mortgage loan was taken out. Standard errors are shown in parentheses. Significant at the *** 1%; ** 5%; * 10% level.

Table 3.15: Predicted mortgage risk and debt literacy: regression results

	[1]	[2]	[3]	[4]	[5]
Debt literacy score	0.127***	0.078**	0.078**	0.072**	0.073**
	(0.032)	(0.031)	(0.032)	(0.034)	(0.032)
Socio-economic controls	No	Yes	Yes	Yes	Yes
Most important sources of information					
Mortgage broker			0.240***	0.257***	0.199***
			(0.059)	(0.059)	(0.058)
Lender			0.03	0.01	-0.012
			(0.058)	(0.058)	(0.056)
Family and friends			-0.108*	-0.103	-0.123**
			(0.065)	(0.064)	(0.062)
Published sources			-0.031	-0.039	-0.035
			(0.056)	(0.056)	(0.054)
Most important sources of information × debt literacy score					
Mortgage broker			-0.107*	-0.114*	-0.100*
			(0.062)	(0.061)	(0.059)
Lender			0.008	0.015	-0.022
			(0.062)	(0.062)	(0.060)
Family and friends			-0.152**	-0.131*	-0.088
			(0.075)	(0.074)	(0.072)
Published sources			-0.027	-0.037	-0.027
			(0.062)	(0.061)	(0.059)
Overconfidence, risk preferences, time preferences and experience					
Overconfidence				0.021	0.029
				(0.049)	(0.048)
Low perceived mortgage risk				0.096***	0.070**
				(0.033)	(0.033)
Risk averse				0.002	0.002
				(0.019)	(0.018)
Low time-preference				-0.023	-0.012
				(0.025)	(0.024)
Number of house moves				0.103***	0.085***
				(0.030)	(0.029)
Income risk					0.232***
					(0.058)
Wealth risk					0.247***
					(0.069)
Constant	0.02	0.674***	0.626***	0.513***	0.216
	(0.056)	(0.122)	(0.120)	(0.144)	(0.149)
Observations	459	459	459	459	459
Adjusted R-squared	0.03	0.22	0.25	0.28	0.33

Notes: (N=459). The dependent variable is the predicted mortgage risk. The debt literacy score measure equals the number of correctly answered debt literacy questions. Socio-economic controls included: gender of the person managing the household finances, marital status, number of children, age dummies, indicators of the education level, income quantiles and a dummy for retirement status. The "perceived risk" variable measures the perceived riskiness of the attributes of a mortgage contract and was derived from a factor analysis of the six different mortgage loan features.
Standard errors are shown in parentheses. Significant at the *** 1%; ** 5%; * 10% level.

Table 3.16: Predicted mortgage risk and basic financial literacy: regression results

	[1]	[2]	[3]	[4]	[5]
Basic literacy score	0.061	-0.005	-0.001	-0.01	-0.002
	(0.046)	(0.045)	(0.045)	(0.050)	(0.048)
Socio-economic controls	No	Yes	Yes	Yes	Yes
Most important sources of information					
Mortgage broker			0.203***	0.225***	0.162***
			(0.060)	(0.060)	(0.058)
Lender			0.002	-0.015	-0.036
			(0.059)	(0.059)	(0.056)
Family and friends			-0.117*	-0.106	-0.132**
			(0.065)	(0.065)	(0.063)
Published sources			0.008	-0.005	-0.006
			(0.057)	(0.057)	(0.054)
Most important sources of information × basic financial literacy score					
Mortgage broker			-0.01	-0.002	-0.016
			(0.093)	(0.091)	(0.088)
Lender			0.107	0.109	0.113
			(0.094)	(0.094)	(0.090)
Family and friends			0.019	0.027	0.133
			(0.106)	(0.104)	(0.101)
Published sources			-0.096	-0.09	-0.102
			(0.092)	(0.090)	(0.087)
Overconfidence, risk preferences, time preferences and experience					
Overconfidence				0.01	0.007
				(0.044)	(0.043)
Low perceived mortgage risk				0.103***	0.080**
				(0.034)	(0.033)
Risk averse				0.009	0.009
				(0.019)	(0.018)
Low time-preference				-0.028	-0.011
				(0.025)	(0.024)
Number of house moves				0.104***	0.083***
				(0.031)	(0.030)
Income risk					0.253***
					(0.059)
Wealth risk					0.267***
					(0.069)
Constant	0.046	0.795***	0.750***	0.652***	0.301*
	(0.124)	(0.160)	(0.159)	(0.173)	(0.176)
Observations	459	459	459	459	459
Adjusted R-squared	0.00	0.21	0.23	0.26	0.32

Notes: (N=459). The dependent variable is the predicted mortgage risk. The basic financial literacy score measure equals the number of correctly answered basic financial literacy questions. Socio-economic controls included: gender of the person managing the household finances, marital status, number of children, age dummies, indicators of the education level, income quantiles and a dummy for retirement status. The "perceived risk" variable measures the perceived riskiness of the attributes of a mortgage contract and was derived from a factor analysis of the six different mortgage loan features. Standard errors are shown in parentheses. Significant at the *** 1%; ** 5%; * 10% level.

Chapter 4

Saving behavior and portfolio choice after retirement

4.1 Introduction

As the babyboomer generation has reached the statutory retirement age, public expenditures on state pensions and long-term care will increase progressively in the coming decades in the Netherlands, as in other West-European countries and the United States. This is due to the aging of the population and increasing life expectancy. In addition, the financial crisis has shown that the pension system is vulnerable to shocks in financial markets. Many Dutch pension funds have had difficulties achieving full indexation of accrued pension rights against inflation, and several pension funds have even had to cut pension benefits.

As a result, substantial reforms of the pension and long-term care insurance system have been announced or already have been implemented in order to ensure sustainability of public finances and the pension system. The pension reforms include a phased increase of the statutory retirement age to 67 years in 2024. After that, the retirement age will be linked to the rise in the life expectancy. In addition, there will be a substantial reduction in the tax-favored pension accrual rate and limited inflation-linking. This will further reduce pension benefits. Changes in the long-term care insurance system imply that only the major disabilities for which self-funding is impossible will be covered. The remainder of care has to be paid out-of-pocket, such as health expenses

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on social support and accommodation costs for persons who stay in a nursing home.

The proposed reforms thus demand that individuals take more responsibility to financially prepare for retirement and secure part of their resources for uncertain health expenses. From a policy perspective, it is therefore important to know the extent of financial resources available to current retirees; whether these resources are sufficient to support them in case of financial shocks such as adverse health events, widowhood or nursing home entry; and whether they will adjust their savings in response to the proposed policy reforms. Answering these questions requires a thorough understanding of saving decisions in retirement. Does a reduction in the provision of health insurance by the Government increase precautionary savings? Will a reduction in pension benefits increase the importance of private wealth holdings and result in smaller bequests? Will the elderly invest more in the stock market to have a larger return on their savings or will they reduce their holdings in risky stocks because of increased health expenditure risk?

This chapter reviews the theoretical and empirical literature about saving behavior and portfolio choice after retirement. Detailed administrative data are then used to provide descriptive evidence about saving behavior and portfolio choice of the elderly in the Netherlands. The linked administrative records contain information on assets, liabilities, pension income, health status and demographics for the period 2005 to 2010. To the best of our knowledge, we are the first to use these administrative records to investigate this topic. The advantage of our data is that we measure assets and also health status with a higher quality than survey data. In addition, rich and poor households are not underrepresented. Data quality problems such as measurement error, sample attrition and item-nonresponse are important concerns for longitudinal analysis such as saving behavior (Venti, 2011; Card et al., 2010).

It is informative to study saving behavior in the Netherlands because of the very different institutional background compared to the US. The almost complete coverage of the health- and long-term care insurance system makes precautionary saving less necessary. Also in the future, saving for long-term care expenses will probably be limited, since the eligibility for public long-term care will depend on the level of wealth. This requires persons to first run down their assets to become eligible for long-term care and penalizes those who find it important to save for this purpose.

The outline is as follows. Section 4.2 surveys theoretical and empirical work on saving- and portfolio behavior after retirement. Section 4.3 describes the administrative data sources. Section 4.4 provides a descriptive analysis of the wealth distribution and portfolio choice of the Dutch elderly. In addition, we indicate how wealth holdings evolve during old-age. Section 4.5 examines how assets are affected by the death of a spouse. Section 4.6 investigates the relationship between health status and the savings

and portfolio choices of the elderly. Section 4.7 investigates the trajectory of wealth in the last years of life. The final section draws conclusions and provides implications for public policy to facility the use of private savings in retirement.

4.2 Theory on saving behavior and portfolio choice after retirement

A simple version of the life-cycle theory of consumption (Modigliani and Brumberg, 1954) without uncertainty and a bequest motive predicts that people accumulate wealth during working life and draw down their savings after retirement to support consumption when income is low. This predicted pattern— that wealth should eventually decline with age— is, however, not found by many empirical studies for several Western countries. According to recent empirical research by Love et al. (2009) and Poterba et al. (2011), median wealth holdings rise in retirement for both single-person households and two-person households— although the rise in wealth tends to be limited among the oldest cohort of single elderly. Their data come from the 1992 to 2006 US Health and Retirement Survey (HRS). These findings hold for different measures of wealth including financial assets, housing equity and "annualized comprehensive wealth", which also includes the expected net present value of pension wealth as well as social security wealth. Similar findings are found in countries with very different institutional settings such as the Netherlands (Alessie et al., 1999) and Germany (Börsch-Supan, 1992).

These results are different from earlier studies that report high rates of dissaving in the 1970s (e.g. Hurd, 1987; Diamond and Hausman, 1984). A possible explanation for the difference is that these studies use a cohort of relatively young retired households who might use their savings to finance involuntary early retirement. Another explanation are the relative high capital gains over the 1992 to 2006 period due to the rise in housing prices and stock prices. This may have caused the observed change in savings to differ from the planned change in savings. French et al. (2007) show that wealth holdings would have declined over the same period if the rates of return on assets were equal to historical rates. Hence, it is important to account for capital gains in the analysis of saving behavior.

All of the studies mentioned above also reported considerable heterogeneity in saving behavior. In particular, richer households and households with a higher level of education tend to save more (see also Hubbard et al., 1995; Dynan et al., 2004; De Nardi et al., 2010). The life-cycle model can be extended in several directions to account for these observations and to provide a more realistic description of the saving behavior of the elderly.

4.2.1 A life-cycle model with lifetime uncertainty

If individuals are uncertain about their remaining lifetime, this might result in a slower decumulation of wealth, as was first shown by Yaari (1965) and Davies (1981). Risk-averse individuals seek to safeguard themselves from outliving their assets in case they become very old. However, the possibility of not getting old also induces individuals to consume more at the start of retirement and reduce consumption at the end of life, as the probability of surviving becomes smaller. In addition, the availability of annuity income, such as social security and pensions, insures individuals against longevity risk and reduces the need to slow down the decumulation of wealth.

In a life-cycle model with lifetime uncertainty, consumption and saving choices depend on two behavioral parameters: the subjective discount rate and the degree of relative risk aversion.[1] Individuals prefer a high level of consumption at the start of retirement if their discount rate is larger than the real interest rate. Frederick et al. (2002), using experimental data to estimate the discount rate, report that the discount rate surpasses the real interest rate— implying that individuals behave impatiently and that consumption declines with age. Mortality risk is an important determinant of saving because it increases the effective discount rate. Since mortality risk increases exponentially as individuals grow older, individuals prefer earlier consumption, and the level of consumption and wealth will further decline with age. The degree of relative risk aversion measures the willingness to alter consumption in response to a change in mortality risk. Risk-averse individuals respond more cautiously to variations in mortality risk. They consume less at the start of retirement and hold more wealth at every age against the risk of living very long— ending up with little more than their annuity income. Of course, with a sufficiently high annuity income there is less need to live frugally; also risk-averse individuals will deplete their wealth at an early age.

Mortality risk is usually measured by life-tables that report the probability of death for the entire population in the next year, for a given age and gender. These life-tables do not account for other important determinants of mortality risk such as socioeconomic status and health status. Differential mortality by socioeconomic status is observed in many studies; Attanasio and Hoynes (2000) and Hurd (2002) show, for example, that wealthier individuals have the tendency to live much longer than poor individuals in the US. Kalwij et al. (2013) show that differential mortality is also an important phenomenon in the Netherlands. As a result, it is impossible to understand saving behavior by observing wealth holdings in cross-section because wealth will increase artificially with age (as was first raised by Shorrocks, 1975). Similarly, individuals born

[1] The referred model assumes that persons have a utility function that is of the constant relative risk aversion (CRRA) form. This is widely used for modeling saving behavior under uncertainty, since it allows for the precautionary motive for saving.

in different periods in time might have different levels of wealth due to productivity differences between cohorts or policy changes that affect specific cohorts. For example, Kapteyn et al. (2005) report the importance of the introduction of the old-age pension system in the Netherlands to explain wealth differences between cohorts.

To assess whether the elderly decumulate their wealth, you therefore need to follow the same households— that do not leave the sample due to death or a change in family situation— over a period of time. The change in wealth holdings within the same surviving households will be unaffected by differential mortality or cohort effects (see e.g. Hurd, 2002). However, in case of differential mortality, the level of wealth holdings— among this selected sample of surviving households— will increase with age. By weighting the data using wealth-dependent mortality rates, the level of the wealth-age profile can be corrected. This approach applied by Attanasio and Hoynes (2000), is contingent on rather strong assumptions. An alternative solution is to stratify the sample by household wealth, as applied by Hurd (1987), for example.

4.2.2 A life-cycle model with bequests

Although a life-cycle model with mortality risk predicts a slow decumulation of wealth if individuals are risk averse, it does not explain why many elderly do not decumulate their assets at all— even at the end of life. A possible explanation is that parents derive utility from leaving a bequest. Hurd (1989) formulates a life-cycle model with intentional bequests. This contrasts with accidental bequests that arise in a model with mortality risk. An intentional bequest motive reduces consumption at the start of retirement and leads to a lower level of consumption in retirement such that more wealth is held at every age.

Hurd's model focuses on retired individuals, such that retirement choices do not have to be explained. Moreover, retirees face no risk of reduced income due to unemployment, which is an important risk factor for elderly workers close to retirement. Individuals receive a certain stream of annuity income and are not able to annuitize their wealth. This is consistent with the low ownership rate of private annuities in the US and in European countries, which is partly explained by the relative high importance of pension and social security wealth in the household portfolios of most retirees (see also the overview of Benartzi et al., 2011, for other compelling reasons). The model also assumes that borrowing is restricted, in the sense that individuals must always have a positive level of wealth. This implies that banks only provide loans that are secured against collateral such as a mortgage loan. Without imposing liquidity constraints, Mariger (1987) shows that individuals with a low degree of risk aversion, who do not plan to leave a bequest, desire to borrow against future pension income as the prospect of death

increases.

The model considers single-person households. For a two-person household, uncertain lifetimes complicate the model considerably because consumption becomes conditional on the expected lifetime of the spouse. In addition, the income of the surviving spouse is most likely different from the income as a couple. In both cases, the couple has to secure sufficient resources for the surviving partner as well as for the planned bequest after the death of the surviving spouse. Another complexity is the existence of returns-to-scale in consumption for couples. If the couple shares many resources, the surviving spouse is, all else equal, worse-off if the partner dies. Hurd (1999) describes the optimal consumption path for elderly couples, which is computational burdensome: to derive the consumption path for elderly couples, the consumption path of the surviving spouse first has to be solved at every age and for each spouse separately. Browning (2000) uses an even more elaborate model in which both partners have independent preferences and have to agree on the level of consumption. The model builds upon the notion that wives are typically younger than their husbands and that they have a higher life expectancy. Therefore, wives have a stronger incentive to save than their husbands. Browning (2000) shows that the higher the relative income share of the wife, the higher the accumulated assets should be, all else equal. Because of the complexity of retirement saving behavior, most empirical studies examine it from the perspective of a single-person household. The work of Lillard and Weiss (1997) is an exception, however; they abstract from important sources of uncertainty which leads to somewhat unsatisfactory results.

In the model, Hurd (1989) further assumes that the marginal utility of leaving a bequest is constant. This assumption results in a closed-form solution of the utility function. This makes the model easier to solve, but leads to the somewhat unrealistic conclusion that bequests are not altruistic, in the sense that they are not motivated by the economic wellbeing of the children. The altruistic bequest motive predicts that the elderly plan to leave a bequest if they expect their children to be less well-off (Becker and Tomes, 1979). Laitner and Juster (1996) provide empirical evidence that planned bequests are indeed larger for parents who have children with relative low lifetime earnings. Hurd justifies this assumption with the argument that bequests are typically a small fraction of the lifetime wealth of the children and therefore only result in a slight adjustment of the marginal utility of the children. It should be noted that this is also consistent with an egoistic bequest motive— in the sense that the accumulation of wealth provides utility by itself: for example, if people are thrifty or derive social status out of wealth.

Another drawback of the assumption of a constant marginal utility is that consumption is independent of the level of wealth at the start of retirement. As a result, wealthy persons bequeath all savings above a certain threshold level of initial wealth and do not

increase consumption. For higher levels of initial wealth this might even result in rising wealth profiles. Carroll (2000) and De Nardi (2004) propose a less restrictive functional form of the bequest function where bequests are a luxury good such that wealthier persons devote a larger part of the wealth holdings to a bequest. In addition, there is a minimum level of wealth under which the household leaves no bequests. Whether or not the household leaves a bequest also depends on the degree of altruism. This functional form is widely used in the recent savings literature; see e.g. De Nardi et al. (2010); Ameriks et al. (2011); Lockwood (2012).

To test whether the bequest motive is prevalent, Hurd fits the life-cycle model to data from the Retirement History Survey (RHS) for the years 1969 to 1979. The model is, however, not able to distinguish between the wealth trajectory of a person with a bequest motive who has a low degree of risk aversion and a risk-averse person who does not plan to leave a bequest. Hurd assumes that only individuals with children have a bequest motive. As a measure of wealth, both net worth and net financial wealth (which excludes illiquid housing equity) are considered. The results support a life-cycle model with lifetime uncertainty, but there is no evidence that individuals with children behave according to a bequest motive.[2] The wealth profiles of individuals with and without children are very similar. Kopczuk and Lupton (2007) use a less stringent assumption to identify the bequest motive. They allow all households to have a bequest motive, independent of whether or not they have children, and show that many elderly households behave according to a bequest motive.

The evidence against the presence of a bequest motive by Hurd is only valid if bequests take place after the death of the surviving spouse. Most elderly singles have lost their partner and it is possible that some of the estate was already split between the surviving spouse and other heirs. For example, Poterba et al. (2011) show that widowhood results in a sharp drop in wealth holdings for the surviving spouse, and Hurd and Smith (2001) report that 80 percent of the estate (which generally excludes the house) is transferred to the children upon widowhood. In addition, parents might prefer to transfer wealth during their lifetime to support their children when they need it most— for example, to alleviate borrowing constraints when they buy their first house or to support them in case of earnings loss. Empirical evidence by McGarry (1999) indicates that lifetime transfers are important for US families, while Ando and Guiso (1994) find no evidence for Italian households, who are known to have strong family ties.

The limited strength of the bequest motive is consistent with survey evidence about

[2]The estimated coefficient of relative risk aversion of 0.73 is considerably smaller compared to what is usually found in the literature, and predicts that retirees will exhaust their wealth at a relative early age. The estimated coefficient of the subjective discount rate of 0.05 is larger than the assumed interest rate of 0.03. This means that the elderly behave impatiently, which results in even faster decumulation of wealth. The exclusion of housing equity does not significantly alter the results.

motives for saving. For example, Dynan et al. (2002) report that the vast majority of retired US households mention precautionary reasons, such as illness or emergencies, as a motive to save, while saving for a bequest is rarely mentioned. Very similar results are found for the Netherlands, even though saving for illness is less urgent because of the comprehensive coverage of the health insurance system (Alessie et al., 1999). Nevertheless, many people state that they expect to leave a bequest, and a significant portion of the children receives an inheritance (Hurd and Smith, 2001). A possible explanation is that savings for precautionary reasons will ultimately be bequeathed if no unforeseen events occur (Dynan et al., 2002). Thus, savings serve a dual role and the importance of both motives cannot be distinguished without additional information. Ameriks et al. (2011) designed a survey question to measure the tradeoff between the size of the bequest and the amount spent on long-term care expenses— which is an important driver of precautionary saving in the US. Their result indicates that intended bequests are an important reason to save.

4.2.3 A life-cycle model with uncertain health expenses

As already mentioned, precautionary savings for illness is an important motive for retirees to save. This might also explain the slow rates of decumulation among the elderly. The amount of risk that the elderly face in case of illness depends on the coverage of health insurance and the availability of social insurance programs.

The importance of uncertain health expenses for saving in old-age was first examined by Kotlikoff (1989). Using a two-period savings model, Kotlikoff shows that partial insurance for severe health problems, such as a prolonged stay in nursing home, is an important reason for middle and upper income households to save. For low-income households, the relatively high costs of medical care in conjunction with the availability of social insurance programs such as Medicaid in the US reduce precautionary savings. These programs secure a subsistence level of consumption for individuals with high out-of-pocket medical expenses. The programs do require individuals to first run down assets, to become eligible. The existence of an asset-test further discourages saving among low-income households. Hubbard et al. (1995) show in a simulation study that the asset-tested safety-net is one of the main reasons why many low-income US households save so little, even close to retirement.

An important assumption in Kotlikoff's model is that the marginal utility of consumption declines in poor health, because individuals are no longer able to consume as much as they desire. This reduces both the level of savings and the desired coverage of health insurance. The direction of the effect can, however, also be positive; see e.g. Finkelstein et al. (2013). For example, the derived utility from hiring a housekeeper or

investing in home adaptations will most likely increase in poor health. Finkelstein et al. (2013) provide empirical evidence that the marginal utility of consumption is lower among individuals with chronic diseases compared to their healthy counterparts. This is consistent with the empirical observation that wealth holdings of the elderly increase with age in countries with comprehensive health insurance coverage; see e.g. Börsch-Supan and Stahl (1991) and Alessie et al. (1999) for German and Dutch evidence on this issue. This is because consumption needs fall below the level of pension income when health deteriorates. Moreover, individuals are unable to borrow against future pension income at the start of retirement, when they have no health problems.

Properly understanding the importance of uncertain health expenses for saving behavior requires precise information about the incidence of large out-of-pocket expenses (similar to the necessity of life-tables to measure mortality risk). The probability distribution of health expenditures strongly depends on age and health status, but may be influenced as well by characteristics such as income and gender. Kotlikoff makes no attempt to precisely measure these risks. Feenberg and Skinner (1994) use information about medical deductions in a longitudinal dataset of US tax records from 1968 to 1973 to estimate the distribution and persistence of out-of-pocket health expenses. Their estimates indicate that health expenses are highly persistent, which reflects the risk of chronic conditions. They also find that health expenses represent a greater proportional risk to low-income households, which implies that they should save more in absence of a social insurance program. French and Jones (2004) use more recent data on out-of-pocket expenses from the HRS between 1992 and 2000. They construct an alternative econometric model that fits both the mean and the upper tail of the empirical distribution of health expenses to better measure the risk of catastrophic health expenses. The parameter estimates of the fitted model are used to simulate lifetime medical expenses. They find that the elderly run a large risk of excessive out-of-pocket health expenses. About 1 percent of the elderly receive a health shock at retirement that results in a present value of lifetime health expenses of more than $ 43,500. This is substantially more risk than indicated by the model of Feenberg and Skinner (1994), and has important implications for the level of precautionary savings among the elderly. There are some concerns that self-reported health expenditures are overstated in the HRS, which increases the estimated health expenditure risk (Venti, 2011).

Subsequent studies by Palumbo (1999) and De Nardi et al. (2010) examine the importance of out-of-pocket health expenditures for precautionary saving by incorporating the estimated health expenditure risk in a life-cycle consumption model. Their models are based on the retirement phase of the framework of Kotlikoff (1989) and Hubbard et al. (1995). They estimate the structural parameters (such as the coefficient of relative risk aversion, the discount rate, the bequest motive and the health state dependent utility)

such that the predicted wealth-age profile of their simulated model closely resembles the empirical wealth-age profile. Palumbo uses data on consumption and health status from the Panel Study of Income Dynamics (PSID) for the years 1984 through 1986 and uses external data sources to measure health expenditure uncertainty. Palumbo argues that in particular the risk of a prolonged stay in a nursing home explains the limited decumulation of wealth in old-age. He does not find evidence for health state dependent utility.

De Nardi et al. (2010) extend the model by allowing for differences in saving behavior between the income-poor and the income-rich, and by accounting for wealth differences between cohorts and differential mortality. They accomplish this by simulating the life-cycle model for different cohorts (with different levels of initial wealth) and by matching the wealth-age profile for different permanent income quantiles and cohorts. The bias due to differential mortality is further reduced by not using population life-tables— and instead allowing mortality risk to differ by permanent income, gender and health status. The data stem from the HRS for the years 1996 through 2006. They use the method of French and Jones (2004) to measure health expenditure risk. Their measure of wealth includes both financial assets and illiquid housing equity. They match the median of wealth rather than means because medians are less sensitive to outliers. This implies that the behavioral parameters of 'an average' household are matched well. The model might be less successful in capturing the behavior of very wealthy households, who might save a large part of their wealth to leave a bequest.

De Nardi et al. (2010) neither find evidence in favor of a bequest motive nor health state dependent utility. The estimated coefficient for relative risk aversion is considerably larger than the one from the model of Hurd (1989). This suggests that health expenditure risk is an important driver of precautionary savings for the higher permanent income groups. Those who have a low permanent income have no incentives to save because they are relatively well protected by the government-provided (asset-tested) safety-net. In addition, out-of-pocket health expenditures are relatively low for the income-poor. The safety-net is also important for the income-rich because they face potential large out-of-pocket health expenditures late in life.

4.2.4 Housing and portfolio choice

While the theories discussed above can explain empirical deficiencies such as the flat wealth profiles, even until advanced ages, they do not account for the fact that the elderly keep a large amount of their wealth in the form of illiquid housing equity (see, among others, Sheiner and Weil, 1992; Poterba et al., 2011). The evolution of housing wealth might be different from the evolution of other kinds of wealth, since a house is both an

asset and a consumption good. If desired housing consumption is constant throughout retirement, this will cause housing wealth to decline more slowly than other kinds of wealth if the ability to extract housing equity is limited (Henderson and Ioannides, 1983).

Households can disentangle the wealth part and consumption part of housing in different ways. First, households can borrow in the form of a second mortgage or take a reverse mortgage. A reverse mortgage allows the household to withdraw a lump sum or receive an annuity payment or a combination of both. The household is able to remain in their home as long as it is their permanent residence. They pay off the accumulated debt when the last household member dies or leaves the house permanently— for example, to go to a nursing home. The lender takes the loss if the value of the debt exceeds the value of the house (but also receives the appreciation in the house value). The demand for reverse mortgages is low among the elderly. This is usually explained by the existence of a bequest motive (e.g. Davidoff, 2010; Lockwood, 2012). This is puzzling, however, because borrowers are also able to withdraw only a part of their housing equity. The complexity of reverse mortgages and the relative high costs— partly to compensate the lender for the risk— are other possible reasons. As a result, households can extract relatively little housing wealth. Sinai and Souleles (2008) calculate that about half of the value of the house can be withdrawn as a lump sum for households at the beginning of retirement. This amount increases for older age groups. Bridges et al. (2006) provide evidence that housing equity withdrawal nowadays occurs more often among elderly households. This might be related to financial innovations in the mortgage market over the last decade, such as the introduction of interest-only mortgages, which allow liquidity-constrained elderly households to better smooth consumption after a financial shock. The obvious concern is that increasing mortgage debt holdings make the elderly more vulnerable to housing price risks; see also Van Ooijen and Van Rooij (2013) for a discussion about mortgage risks.

Households can also extract housing equity by selling the house and becoming a renter or by purchasing a less expensive house. Relatively few households extract equity by moving to a less expensive house in later life, as documented by Sheiner and Weil (1992) and Venti and Wise (2000). This implies that a considerable amount of equity is not used for consumption purposes. There are several potential explanations for the low turnover rate among elderly people. First, the elderly might want to bequeath the house to their children. The evidence about the importance of a bequest motive is, however, not particularly strong. Second, households may use their housing wealth as a buffer against catastrophic shocks such as the death of the spouse or uncertain medical care at the end of life. They leave the remaining wealth as an incidental bequest. Suggestive evidence in favor of this explanation is provided in a recent study by Ameriks et al.

(2011). Third, moving involves not only large monetary costs but also emotional costs of settling into a new environment. Venti and Wise (2000) use survey questions which indicate that the elderly are indeed very accustomed to their house and have no intention of moving to a smaller house. Rouwendal and Thomese (2013) show that homeowners are more attached to their house and are less likely to become institutionalized even if health deteriorates.

The issue of adjustment costs associated with housing wealth and consumption behavior was recently investigated by Chetty and Szeidl (2007). They develop a life-cycle model in which households derive utility from housing and non-housing consumption such as clothing and food. Households are unable to extract equity from the house or to adjust the size of the house without selling the house and incurring adjustment costs. Households are willing to incur the adjustment costs only when a large permanent shock occurs (such as death of the spouse or deteriorating health). As a result, they are more averse to smaller risks and keep a buffer of financial assets for incidental expenditures. When confronted with a small health shock, households first draw down their liquid assets before downsizing their home equity. Davidoff (2010) argues that since the desired level of housing consumption also declines after a large health shock, housing equity serves as an ideal saving device for out-of-pocket medical expenditures. Yogo (2009) provides a model with health investments and adjustment costs that also predicts that households primarily dissave in the form of housing equity after a large health shock.

There are a few recent studies that empirically explore the impact of health status on portfolio allocation of the elderly using data from the HRS, thereby explicitly taking into account the presence of illiquid housing wealth. For example, Berkowitz and Qiu (2006) and Coile and Milligan (2009) show that the onset of a new chronic condition leads to a much larger decline in financial wealth than in housing wealth. They do not consider, however, the long-run effect of a health shock. Medical expenses related to a chronic condition last for a long time, which gradually drains household savings. Yogo (2009) finds that individuals primarily reduce housing equity in response to a large decline in self-reported health between two waves of the HRS.

Finally, Flavin and Yamashita (2002) and Chetty and Szeidl (2010) examine the effect of housing equity on portfolio choice. Their models predict that households will invest a larger share of their financial portfolio in risky assets, as their exposure to housing price risk declines. This implies that the portfolio share of risky assets increases with age, since people reduce their mortgage debt. Moreover, a smaller mortgage debt translates into lower monthly payments over the remaining term of the mortgage. These lower payments make households less vulnerable to financial shocks. Pelizzon and Weber (2009) test these predictions using Italian household data. They show that housing

wealth plays a key role in financial portfolio choice.

4.3 Data sources

We use linked administrative records from Statistics Netherlands to provide descriptive evidence about saving behavior and portfolio choice after retirement.

4.3.1 Dutch Income Panel

The Dutch Income Panel (IPO) contains detailed information on income, at both the individual and the household level, and on assets and liabilities at the household level. The data stem mainly from the National Tax register. It should be noted that the Dutch tax administration levies a wealth tax ('box 3 tax') if net financial wealth exceeds a certain threshold, which depends on marital status.[3] In order to check whether people report their financial wealth in a correct way, the tax authorities require banks and insurance companies to provide relevant data on financial wealth of all their clients (data on checking and savings account balances, and on their investment portfolio). Both income and assets are therefore accurately measured.

IPO started in 1989 and consists of about 90,000 households. The unit of observation is the "key person" of a household, which is drawn randomly from the Dutch population and is followed over the life course. The dataset contains information about the key person and all household members. When the key person moves to another household or drops out of the sample because of death or migration, we lose all information of the remaining household members. The IPO is linked to the Dutch population register, which includes demographic variables such as age, gender, marital status and country of birth. We also use the population register to obtain information about the number of children and whether an elderly person resides with an adult child.

Data on financial wealth holdings are available from 2005 onwards. Therefore, we only use the 2005 to 2010 waves of the IPO. Due to its administrative nature, the IPO data has many advantages above other survey datasets on income and asset holdings. First, it has a very low attrition rate (due only to migration) and includes individuals who are either under-represented or not represented in most surveys (such as the rich, immigrants, single-person households, the elderly population, and individuals living in institutions). Another advantage of the data is that the observed wealth and income variables are measured with high accuracy, which is of crucial importance for studying wealth changes. In addition IPO measures precisely the following sources of pension income: social security payments (AOW), occupational pension benefits and third-pillar

[3] € 20,661 for single-person households and € 41,322 for couples in 2010.

annuity income. The IPO does not make a distinction between occupational pension benefits and income from privately purchased annuities. It only records the sum of these two income components. Item non-response and misreporting of assets is a serious problem when using survey data to study saving behavior. For example, Venti (2011) reports that 80 percent of US households who participate in the HRS misreport the ownership of bonds and more than 40 percent of the households provide incorrect information about the ownership of private retirement savings. This leads to large artificial changes in asset ownership and asset holdings between survey waves.

In principle, year-end values of all asset and debt items are reported in the IPO. However, there are some problems with the valuation of the owner-occupied house. Statistics Netherlands mainly bases this valuation on the WOZ value. The WOZ value, which is determined by the government, is equal to the average value of similar houses in the neighborhood that are sold during the previous calendar year. The WOZ value can therefore be seen as a good proxy for the value at the beginning of year. Statistics Netherlands has used a nationwide house price index to inflate the WOZ value in order to proxy the year-end value of owner-occupied housing. This procedure works fine for all households except for those who were homeowner at the beginning of the year but moved to a rented accommodation during the calendar year. Statistics Netherlands incorrectly assumes that people in this group are still homeowners at the end of year, and that a year-end house value should be assigned to this group of households. Fortunately, the IPO dataset contains enough information to correct this; and we have done so.

4.3.2 LMR and CAK

To measure health status of IPO respondents, we merge information from the 1995 to 2010 hospital discharge register (LMR) into the IPO dataset. The LMR contains information about hospital admission and covers all general and university hospitals and most specialized hospitals. The information includes, among other things, the main diagnosis and medical treatment, date of admission and discharge, and whether the admission is acute. The diagnosis and treatment are based on the international classification of diseases (ICD-9).

We distinguish between three categories of health: major diseases, minor diseases and the remaining group with no health problems. In case of the first type, the key person or the partner entered the hospital because of a 'severe illness'. We say that a person suffers from a 'severe illness' if they are diagnosed with cancer or cardiovascular diseases in the last three waves (i.e. wave t, $t-1$or $t-2$). Smith (2004) and Datta Gupta et al. (2011) identify severely ill people in a similar way. We define the second group of households to have a 'minor health condition' if neither the key person nor

the partner are severely ill, but at least one of them is admitted to the hospital during the last three waves. The third group consists of the rest, who are not admitted to a hospital in the past waves.

Information about long-term care utilization is provided by the CAK institute, which executes financial compensation programs for long-term care users. The data contains information about the days spent in a nursing home and number of hours of nursing and personal care provided at home for the years 2004 to 2011.

4.3.3 Sample selection

Our sample includes all households of which both the key person and the spouse are retired. Individuals are considered to be retired if they are at least 65 years old and receive pension income and not earnings or business income. We exclude retired individuals younger than the statutory retirement age of 65 from our sample, since early retirement might be endogenous with respect to wealth; see Van Ooijen et al. (2010) for evidence about the effect of wealth on early retirement for households in the Netherlands. We also exclude a few households that left the sample between 2005 and 2010 because of migration. We also remove those households whose key person resides with an adult child. We made this selection because IPO measures wealth at the household level. Consequently, we cannot disentangle the wealth of the parents and their adult children. For the same reason, we do not observe wealth of key persons who have permanently entered a nursing home. According to Statistics Netherlands, people living together in one nursing home form one composite household. Again, these observations are discarded. The prevalence of remarriage or divorce after retirement is very low in our sample. Moreover, in economic models explaining the saving behavior of retirees, it is typically assumed that individuals neither divorce nor (re)marry. Since we want to test the predictions of these models, we limit our sample to those households who do not change marital status other than widowhood, and thus exclude persons who remarry or divorce during the sample period. This leaves us with a sample containing 9,280 households in 2005. The sample consists of 5,047 married couples (of which 72 married couples live separately and apart because of nursing home entrance), 1,184 never-married persons and 3,049 widowed persons.

4.4 Saving behavior and portfolio choice of the Dutch elderly

4.4.1 Economic resources after retirement

Retired households have three important sources (of income and wealth) to support consumption during retirement. They depend on private savings and annuity income which they have built up during working life. In addition, they receive income from accumulated wealth holdings such as interest income, dividend payments and capital gains. Homeowners also receive implicit income from housing services, since they do not have to pay rent.

Annuity income consists of three components. In the Netherlands, all residents receive a state pension (AOW) at the statutory retirement age of 65. The benefit level is equal to the minimum wage for a two-person household, while a single-person household receives 70 percent of the minimum wage. Unlike the US Social Security system, the benefits do not depend on the work history. As a result, the poverty rate is very low among the elderly. Less than three percent of the Dutch retirees receive a state pension below the poverty line (Soede, 2012), while Poterba et al. (2012) show that about one-third of single-person households in the US lives in poverty in the last year of life. In addition to social security, the large majority of retirees are covered by an occupational pension scheme (Bovenberg and Gradus, 2008). Participation is mandatory when the employer offers a pension scheme. The pension scheme is predominantly of the defined-benefit type, and promises a replacement rate of 70 percent of average earnings. The accrued pension rights depend on the years of work. In the Netherlands, pension funds do not offer the option to cash out pensions in the form of a lump-sum payment; also in countries such as the US and Switzerland, which offer the option of a lump-sum payment at retirement, the large majority of individuals choose not to cash out (Benartzi et al., 2011). Finally, retirees receive annuity benefits from privately purchased life insurance. The contributions are tax-deductible for individuals with income over which no pension rights are accumulated (such as the self-employed).

Because of the generous social security and pension benefits we consider not only private wealth, but also social security and pension wealth. The present discounted value of social security and pension wealth depends on the (joint) life expectancy of the household members, the assumed discount rate, and the ratio of the survivor benefits to couple benefits. In the Netherlands, the spouse usually receives 70 percent of the couple benefits upon entering widowhood (Brown and Nijman, 2011). This allows us to compare the relative importance of both private wealth and annuity income for the economic status of the elderly. We will not examine the evolution of pension and

socials security wealth in retirement because this is in general out of control once the youngest household member retires. In the Netherlands, banks usually do not allow borrowing against future pension and social security income. However, banks usually provide loans that are secured against collateral such as an interest-only mortgage—also when borrowers are at an advanced age. Furthermore, other than the survival benefit, pensions are not bequeathable. The size of these wealth measures, therefore, declines mechanically with age as the mortality risk increases.[4]

We distinguish between three definitions of private wealth holdings: net worth, net financial assets and housing equity. Net worth of the household is defined as the value of all assets less the value of all debts; see Wolff (1998) for a definition of household wealth. Total assets are defined as the sum of the values of the owner-occupied house, other real estate, checking and savings accounts,[5] risky assets (i.e. stocks, bonds and mutual funds), business wealth and other assets such as cash in hand and loans to family members. Total debts are defined as the sum of mortgage debt, business debt and other debt.[6] Housing equity is equal to the value of the owner-occupied house minus the remaining mortgage debt. Net financial wealth equals net worth minus housing equity. These measures do not include durable goods (such as cars) or the cash value of privately bought life insurances.

In the Netherlands, mortgages are commonly linked to a life-insurance policy: so-called endowment mortgages. For these products, the mortgage debt remains constant over the term of the mortgage loan, in order to take advantage of the generous tax-deductibility of the mortgage interest. The owner pays interest over the mortgage principal and an insurance premium to a life-insurance policy which covers the mortgage principal at the end of the loan. Since the cash value of the life-insurance policy is not observed in the data, housing equity is underestimated for these households. The ownership rate of endowment mortgages is, however, very low among elderly homeowners; see Van Ooijen and Van Rooij (2014). The most common mortgage among elderly homeowners is an interest-only mortgage where the borrower pays interest but does not repay the principal.

[4]We use the formulas of Alessie et al. (1997) for the computation of pension and social security wealth. We use cohort-specific life-tables from Statistics Netherlands. We assume that the remaining lifetimes of the key person and spouse are independent. The discount rate is 3 percent and survivor benefits equal 70 percent of the couple benefits. The maximum lifespan is 110 years.

[5]Financial institutions are not obliged to report to the tax administration bank account balances less than 500 euro. Consequently, IPO slightly underestimates ownership of bank accounts at the household level.

[6]Other debt is only known for those households who pay wealth tax ('box 3 tax'). Consequently, the debt ownership is underestimated. However, data from the DNB Household Survey (DHS) indicate that the overwhelming majority of the 65+ households do not hold any form of consumer credit; see Alessie et al. (2002).

4.4.2 Household wealth holdings in 2005

We first examine the economic status of households after retirement in 2005. This is well before the stock markets reached rock bottom in September 2008 after the bankruptcy of Lehman Brothers, which led to the financial crisis. Table 4.1 reports on the distribution of household wealth across different age groups and marital status of the key person at the end of 2005. We distinguish between married couples, widowed persons and non-married persons (i.e. never married or divorced).

We first look at married couples. The average net worth of married couples in their early retirement years (age 65-69) is equal to € 267,400. Not surprisingly, the distribution of wealth holdings is skewed to the right: mean net worth equals somewhat more than one and a half times median net worth. This implies that a large fraction of net worth is owned by the very rich. Notice also that median net worth declines with age from about € 159,000 for the 65-69 age group to about € 67,000 for the 85+ group. At the same time, mean net worth remains fairly constant with age. This indicates that wealth inequality increases with age. Housing equity is the most important component of the household portfolio for married couples at the start of retirement: its average value is equal to € 149,000. About 55 percent of the couples in the sample own a house in their early retirement years. This is a sharp increase compared to the ownership rate in the beginning of the 1990s. Alessie et al. (1995) document that approximately 23 percent of the 65-69 age group own a house in 1991. Nevertheless, the homeownership rate is still considerably lower than that of the US, where more than 90 percent of the just-retired couples own a house (Poterba et al., 2011). The low homeownership rate is still prevalent among the older generation of retirees. Approximately 30 percent of the married couples age 85 and older own a house. This does not so much reflect the draw-down of housing equity as people age but the cohort differences, which is also documented by Van Der Schors et al. (2007). Wealth holdings are less equally distributed when housing equity is excluded. Median financial wealth amounts to about € 30,100, while mean financial wealth equals € 118,800; this is almost four times as high as the median. For all but the youngest cohort, the mean level of net financial wealth among older cohorts is higher.

Social security and pension wealth represent an important part of total wealth holdings. Together they account for more than 60 percent of total household wealth for the age group 65-69. This percentage was even higher in the early 1990s (Alessie et al., 1995). Almost all married couples receive occupational pension benefits on top of social security wealth. We see that the older age groups less often receive occupational pensions. Among the individuals who receive occupational pensions, there is considerable variation in pension wealth: for couples, mean pension wealth (€ 231,800) is twice as

large as median pension wealth (€ 157,500). This reflects differences in lifetime income. The skewness is similar to the distribution of net worth.

Wealth holdings of single-person households are considerably lower than those of married couples. The table shows that mean net worth of married couples for the age group 65-69 is about 40 percent higher than for widowed persons (€ 193,600) and almost twice as high for non-married persons (€ 139,100). The wealth distribution of single person-households is also more dispersed compared to married couples. For widowed persons (age 65-69) mean net worth is almost five times as high as the median (€ 41,600). Net worth is even more unequally distributed among non-married persons. A typical (median) non-married person in the age group 65-69 has only € 13,700 in net worth and € 9,500 in liquid financial assets for immediate consumption. This inequality in net worth is again partly explained by differences in homeownership, which is about 15 percentage points lower among widowed persons in the age group 65-69 (40.9 percent) than it is among married couples. The homeownership rate is even lower among non-married persons; only 28.5 percent own a house between age 65 and 69, and the homeownership rate is less than 20 percent for persons age 85+. The difference in both median net worth and the homeownership rate between widowed and unmarried households disappears at older ages.

Most single-person households at the bottom half of the wealth distribution thus highly rely on social security and pension wealth in retirement. The ownership of pension wealth is slightly higher among married couples than among widowed persons for all age groups. This implies that the vast majority of widowed persons receive a survivor pension. The ownership rate is, however, substantially lower among non-married persons: about 75 percent receive an occupational pension in the age group 65-69, with the figure dropping to only 60 percent of the persons age 85 and above. These results suggest that the economic status of non-married households in the age group 65-69 is lower than that of widowed persons in the same age group; for older age groups, the economic status of non-married persons increases. In the subsequent sections we will focus only on married couples and widowed persons.

4.4.3 Evolution of household wealth between 2005 and 2010

The described cross-sectional distribution of wealth compounds age- and cohort-effects. The panel dimension of the dataset allows us to follow the same household over time. We can therefore distinguish between true age effects and cohort-time effects.[7] Furthermore, we are able to account for differential mortality. We therefore restrict the sample to all

[7]We could not disentangle either age or time and cohort effects without making additional assumptions such as done in e.g. Deaton and Paxson (1994). This is because the age of an individual is perfectly identified by the year of birth (cohort) at a specific time.

households that remain intact to the end of the panel. This implies that we exclude all households where one of the members dies between 2005 and 2010 and keep a balanced panel.

Table 4.2 shows the evolution of wealth between 2005 and 2010 for married and widowed persons in their early retirement years for the balanced panel. These households are between 65 and 69 years of age in 2005 and between 71 and 75 years of age in 2010.

Note that mean and median wealth holdings for both married couples and widowed persons in 2005 are slightly higher compared to the same statistics in Table 4.1. Households with a lower level of net worth thus have higher mortality risk. The table shows that the evolution of net worth between 2005 and 2010 is largely affected by developments in the housing market and the stock market. Between 2005 and 2007, the average net worth of married couples increased by 6 percent: from € 276,100 to € 293,600. This is in particular due to the rise in housing prices in the years before the financial crisis: the mean level of housing equity rose by 7.5 percent between 2005 and 2007. Wealth held in financial assets did not grow as fast over the same period: mean financial wealth rose by about 4.5 percent between 2005 and 2007, while the Dutch stock market index doubled over the same period. This observation that the level of financial assets remained fairly constant between 2005 and 2007 is reasonable, since risky assets are not an important component of most household portfolios. There is a large decline in net worth in the years after the economic crisis, particularly because a substantial amount of the wealth holdings of the elderly is tied up in housing equity. The wealth holdings of the elderly are thus sensitive to the volatility of housing prices in the studied period. During the financial crisis, the mean housing equity of couples declined by 15.4 percent— from € 166,300 to € 140,700. As we will show below, mortgage debt is limited among the retirees. This makes a decline in housing prices less critical for the elderly, compared to younger generations who usually have a larger mortgage debt compared to the value of their property. The decline in the prices of houses mainly affects elderly homeowners who move home during the downturn— because of deteriorating health, for example, or death of the partner. For individuals who move to another owner-occupied house, the net reduction in housing equity is limited, however, since the purchase price of the new house declined as well (Sinai and Souleles, 2005). The data shows that elderly couples in the age-group 65-69 do not seem to move. The homeownership rate remains fairly constant between the years 2005 to 2010.

Mean financial wealth declined by more than 11 percent between 2007 and 2010, while median financial wealth declined only slightly over the same period. Apparently, net financial wealth of a typical household is not affected by the downturn of the financial markets,[8] either because households sold their stocks in the first phase of the financial

[8] In 2008 the Dutch stock market exchange lost about half of its value.

crisis when prices started to fall, or because of the limited importance of risky assets in the average financial portfolio. In the next section we show that households already reduced stockownership two years before the financial crisis.

For widowed households we observe a similar profile for net worth, both before and after the financial crisis. The level of net worth is considerably lower compared to married couples. The median net worth profile is remarkably flat among widows because of the relative low homeownership rate. The median level of financial wealth is just below the threshold for the exemption of wealth taxation for single households, which is a finding we also have for married couples.

Figure 4.1 also presents the mean wealth-age patterns for the older cohorts. In the figure, each 'cohort line' is composed out of households born in five consecutive years. The first line matches the cohort as displayed in Table 4.2. For married couples we use four cohorts, where the oldest cohort is 80 years and older in 2005. For widowed households we use five cohorts, where the oldest cohort is age 85 and older in 2005. Since a person's year of birth is perfectly identified by his age at a specific date in time, we cannot distinguish between age and time effects without making additional assumptions. If we assume that each cohort is affected in a similar way by time effects such as developments of the stock market and housing price developments (which is not unreasonable to assume), we can discriminate between both effects by comparing the shape of the wealth-age profile of different cohorts.

We first look at the wealth-age profiles of married couples. For all cohorts we observe that net financial wealth rises slightly in the years before the financial crisis and significantly declines thereafter. For all cohorts, net financial wealth rises slightly in the wake of the financial crisis when stock markets recover. The shape of the wealth-age profiles of the different cohorts is thus very similar. This suggests that time-effects dominate the picture and that age-effects are limited. There seems no evidence that married couples run down their financial wealth as they get older. Even the oldest cohort (aged 80 to 85+ in 2005) retains their financial assets. This finding seems to be at odds with the prediction of a simple life-cycle model which says that retirees should eventually deplete their wealth holdings.

Median net financial wealth holdings are significantly lower compared to the mean (see Figure 4.2). Notice also that the median level of financial wealth among the oldest cohorts is even higher compared to the youngest cohort. This might reflect differential mortality, or differences in portfolio composition between cohorts (because of the lower homeownership rate among the older cohorts). For all cohorts, median financial wealth does not decline over time and seems not affected by the financial downturn of the stock market because of the limited stock ownership in the bottom half of the wealth distribution. The pattern suggests that a typical household behaves as a buffer stock

saver. They keep a target level of liquid savings for precautionary reasons— for example, in case they become ill, to replace durable goods or to support their adult children with financial strain. Households will increase savings after a financial shock until they reach the target; see Carroll (2001).

Figure 4.2 shows that the homeownership rate is substantially lower among the older cohorts. The jumps between the lines indicate that cohort effects are important. As households age, we observe a slight decline in the homeownership rate for all but the youngest cohort. The cohort differences in homeownership explain the differences in the shape of the median net worth profiles for couples.

For widowed persons, the profile of mean net worth is very similar compared to married couples. However, the level of net worth is significantly lower for all cohorts. For widows, we also observe for most cohorts a slight decline in the homeownership rate over time. This, reduction is not large enough to explain the level difference in homeownership between widows and married couples. In section 4.5 we show that widowhood explains part of the difference in the level of both housing equity and net financial wealth between widowed persons and couples. The median net worth profile is very flat among widows because of the low homeownership rate. The median level of financial wealth approaches the threshold for the exemption of wealth taxation for all cohorts. It thus seems important to take account of the tax system in order to understand the saving behavior of households.

4.4.4 Financial household portfolios in 2005

Table 4.3 summarizes the composition of the financial portfolio for both married couples and widowed persons in 2005. For each asset and debt item, the table presents the mean value, the ownership rate and the mean portfolio share. The mean portfolio share of an asset or debt item is defined as the ratio of its value over the sum of total assets. We add together other real estate, business wealth and other assets in a single asset item. We also combine other debt and business debt in a single debt item. We refer to these portfolio components as ‘other assets’ and ‘other debts’, respectively.

Once again, the importance of housing in the composition of wealth becomes apparent. Housing is a very important wealth component especially for younger retired couples (age 65-69): 56 percent of those couples own a house and its mean portfolio share is equal to 44 percent of total assets. Interestingly, the majority of those younger retired homeowners (36 percent out of the 56 percent) still have a considerable mortgage outstanding: the average loan-to-value ratio (among those who have mortgage outstanding) equals 18.3 percent. Both the fraction of homeowners with an outstanding mortgage loan, as well as the size of the mortgage loan, are substantially lower among older age

groups.

Checking and savings accounts comprise the second-most important item in the portfolio of retired couples, and this item becomes the most important component at older ages. For couples aged 65 to 69 these accounts represent 47 percent of portfolio holdings; this fraction increases to almost 70 percent of total assets for couples aged 85 and older. About 30 percent of the couples in the age range 65 to 69 invest in risky assets such as stocks, bonds and/or mutual funds. The ownership rate is only slightly lower among the older age groups.

Couples in the age group 85+ invest on average 9 percent of their total assets in risky assets. This is a larger share than younger retired couples, who invest about 5 percent of their financial portfolio in risky assets. This finding can be partly explained by differential mortality; the life-cycle model with uncertainty predicts that wealthier individuals invest a larger share of their assets in risky assets; see e.g. Gollier (2002). Another explanation by Flavin and Yamashita (2002) is that since the portfolio of the elderly is less dominated by risky housing equity, they can allocate a larger share of their liquid assets to stocks and mutual funds. Coile and Milligan (2009) find very similar patterns for US households with respect to the share and ownership of risky assets. The ownership rate of risky assets (excluding individual retirement accounts) is slightly higher: approximately 40 percent of US households in the age group 65-69 invest in stocks and bonds in 2002.[9]

Table 4.3 also presents the composition of wealth holdings among widowed persons. Homeownership is less common for widowed persons than for couples: the homeownership rate is almost 15 percentage-points lower among all age groups. In addition, widowed persons hold less mortgage debt: the loan-to-value ratio is about 14 percent for younger retirees and less than 2 percent at age 85+. The main part of total assets is kept in checking and savings accounts. Risky assets are of minor importance: between ages 65 and 70, the ownership rate of risky assets is about 21 percent, reducing to about 14 percent above age 85. Risky assets comprise between 5 and 6 percent of total assets for all age groups, which is slightly lower compared to couples. The fact that widowed persons hold less risky portfolios (with respect to both assets and debts) compared to couples might be because they possess less wealth holdings. An alternative explanation might be that the majority of widowed persons are female. Females are more risk averse and less experienced in making financial decisions regarding stock ownership; Van Rooij et al. (2011).

Table 4.4 shows that there is indeed a clear association between wealth and the composition of the financial portfolio. The presented information is similar to that in

[9]Information about dividends and capital gains in IPO (for households who pay wealth tax) indicates that among all age groups the ownership rate of risky assets was substantially higher in 2002.

the previous table but the results are stratified by net worth quartile for both married couples and widowed persons (for each age group separately). For couples in the top wealth quartile, assets in checking and savings accounts are of minor importance. They hold a relatively large share of their wealth holdings in risky assets and housing wealth. The share of risky assets increases with age while housing wealth becomes less important: 66 percent of the younger retired couples own risky assets and 96 percent own a house. The homeownership rate declines to 81 percent among the oldest retirees in the top wealth quartile, while the ownership rate of risky assets is slightly lower (about 60 percent).

For couples in the third wealth quartile we also see that housing is the dominant asset in the portfolio. The homeownership rate is more than 95 percent at the start of retirement and is about 40 percent for surviving couples who reached age 85. The ownership of risky assets is significantly lower compared to couples in the top net worth quartile: about 27 percent of the younger couples own risky assets and the share of risky assets to total assets is less than 3 percent. We again observe a shift, as individuals grow older, from housing wealth to risky assets. For the second wealth quartile we observe that housing equity is of minor importance: only 28 percent of the younger retirees own a house, and for the oldest age group all retirees in the second wealth quartile rent a house. Risky assets are relatively important among younger retired couples in the second wealth quartile: the ownership rate is around 21 percent between age 65 and age 70, and declines to 7.5 percent for couples aged 85 and above. The share of risky assets is somewhat higher for the younger age groups compared to the third net worth quartile (between 5 and 7 percent). Couples in the bottom wealth quartile have hardly any assets other than checking and savings accounts.

For widows we also see the importance of housing wealth in the portfolios of the top wealth quartiles at the start of retirement (Table 4.5). However, the homeownership rate is almost zero for the oldest age group in the third wealth quartile. For the other wealth quartiles checking and savings accounts are the dominant asset category. We observe a shift from housing assets to risky assets among the older age groups in the top of the wealth distribution. The ownership rate and portfolio share of risky assets is much lower compared to couples for all wealth quartiles, which we already observed in Table 4.3.

4.4.5 Evolution in household portfolios between 2005 and 2010

As we explained above, to distinguish between age, time and cohort effects we have to follow the asset holdings of the same cohort of households over time. Table 4.6 reports the participation rate in different asset classes for the cohort aged 65 to 69 in 2005.

We follow the same cohort for six years. Consider first the ownership rate of risky assets among married couples: in 2005, slightly more than 31 percent participate in the stock market. Subsequently, this declines to 28 percent in 2007, and drops further during the financial crisis to a little less than 24 percent in 2010. The decline in the participation rate thus already set in two years before the large drop in asset prices after the bankruptcy of Lehman Brothers. It is unclear whether this decline can be fully attributed to a time trend or whether age-effects explain this profile (as predicted by the life-cycle model).

Figure 4.3 also shows the evolution of asset classes for older cohorts spaced at five-year intervals. The older cohorts also experience a decline in the ownership rate of risky assets over the same period. This suggests that time-effects are important and that there is little evidence that the elderly exit the stock market as they age. This is, however, inconclusive; a longer time series is necessary to make a decisive statement. Table 4.6 also reports the evolution of the risky assets share of total assets, which we refer to as the portfolio share of risky assets. The portfolio share of risky assets reduces only slightly as people age and seems to follow the participation profile. At the same time, the portfolio share of checking and savings accounts increases. Thus, the data suggest that the elderly rebalance their portfolio away from risky assets due to the increased uncertainty about the economic environment.

As already mentioned, the stock market participation rate among widowed persons is about 10 percentage-points lower compared to married couples in the 65-69 cohort. A comparison of the risky asset-profile among different cohorts shows that the decline in ownership slows down for the older cohorts. For the 85+ cohort, the ownership rate stays constant at about 15 percent between 2005 and 2010. A possible explanation for the limited liquidation of risky assets is that the elderly start managing their portfolio more passively as their cognition declines; another explanation is that their time horizon increases due to a bequest motive.

Next, we examine the evolution of the ownership of mortgage debt and housing. For the 65-69 cohort of married couples, the homeownership rate in 2005 is about 60 percent, and about two-thirds of the homeowners still have a mortgage outstanding. The homeownership profile stays very flat over the years. In addition, it appears that this group of young retirees redeems their mortgage at a very slow pace: mortgage ownership declines from 37.7 percent to 34.4 percent in 2010. Similarly, the average portfolio share of mortgage debt stays fairly constant over the years (around 4.7 percent of total assets). This is different from the behavior of US households, which seem to reduce mortgage debt after 2007 (Dynan et al., 2012). The decline in mortgage debt is mainly caused by borrowers who default on their mortgage loan. Mortgage defaults occur less often in the Netherlands and do not result in a decline of household debt.

This is because mortgage loans in the Netherlands are with recourse, which means that the borrower is liable for the deficiency in case of default. Another reason for the low number of mortgage defaults is that lenders judge the affordability of mortgage payments when applying for a loan.

Figure 4.3 reports a more rapid decline in mortgage ownership among the older cohorts. Nevertheless, among all cohorts the loan-to-value ratios decline only slightly in the years before the financial crisis, and increase slightly after 2007 when house prices decline. This reflects the importance of interest-only mortgages for the elderly. The elderly do not pay off the mortgage principal before the end of the loan. Among the oldest cohort of couples (age 80+ in 2005), about a quarter of all homeowners still have a mortgage outstanding (10 percent), with an average value of about 10 percent of the value of their house. This stresses the potentially important role of interest-only loans to extract housing equity for the elderly. The provision of home equity loans to elderly persons is relatively riskless for financial institutions, since the loan-to-value ratios are relatively low.

4.4.6 Wealth holdings, financial portfolios and pension income

As shown above, a large fraction of the elderly has accumulated significant savings mainly in the form of housing equity. This holds in particular for the younger cohorts. For the bottom part of the net worth distribution and for the older cohorts, housing equity is less important: they essentially keep all of their savings in a bank account. At the median, we observe that the elderly have accumulated a decent buffer of financial wealth, high enough to cover small unexpected expenses but too small to significantly increase consumption in retirement. These households depend mainly on social security and pension income to support retirement consumption.

Table 4.7 shows the cross-sectional wealth distribution in 2005 by age and lifetime income tertile. We formulate lifetime income tertiles for both widows and married couples among age groups. We take the average of the sum of pension and social security income between 2005 and 2010 as a measure of lifetime income. This is a good indicator of lifetime income, since it reflects average earnings during working life.[10] First of all, it is evident that wealth and lifetime income are strongly correlated. Among all age groups, couples with a higher lifetime income have accumulated disproportionally more wealth compared to individuals with a low lifetime income. Married couples between the ages 65 and 69 in the bottom income tertile have on average € 96,200 in net worth, the middle quantile has € 172.900 in net worth, while the upper tertile has € 533,700 in mean net worth. At older ages, the difference between the lowest two income

[10]The replacement rate for low-income groups is, however, somewhat higher compared to high-income groups.

tertiles disappears. For widowed persons, we observe very similar patterns as for couples. Households with a low lifetime income presumably have limited possibilities to save, which results in lower levels of wealth in retirement. There is, however, considerable heterogeneity in savings within all lifetime income tertiles. We find that net worth is unequally distributed particularly among households in the lower income quartiles, for all age groups. Consider, for example, married couples aged 70 to 74 and in the highest income tertile; mean net worth (€ 453,600) is 1.4 times higher than median net worth (€ 326,700), while for households in the lowest income tertile mean net worth (€ 116,600) is 4.8 times as high as the median (€ 24,100). The difference between the mean and median among persons with low lifetime income is less prevalent for financial wealth; the heterogeneity in accumulated net worth among the low-income groups is thus largely explained by housing equity: low-income households who bought a relative inexpensive house before the 1990s, accumulated substantial housing equity due to the high rates of return on housing as from the early 1990s. In addition, mortgage payments result in "forced" savings before retirement and allow them to consume more after retirement, when they are mortgage-free and therefore have low housing costs. For low-income groups, therefore, housing might work as a commitment device in which they are forced to save; see Thaler and Shefrin (1981). They can significantly improve their economic status in retirement by extracting housing equity to increase consumption. An important remaining question is, therefore, which factors determine homeownership status among low-income households in working life. Potential factors that reduce the demand for owner-occupied housing among low-income groups are the lower marginal tax rate, which results in lower mortgage rate deduction, and subsidized rents in the social housing sector.

Figure 4.4 shows the evolution of median net worth between 2005 and 2010 for widowed persons among different lifetime income groups and cohorts. The figure indicates that the profile of median net worth is very flat for all but the highest lifetime income group. A typical household in the bottom two income groups mainly holds riskless assets in checking and savings accounts, which remain rather unaffected by economic developments. Median savings are low among these groups and appear to be affected by the threshold for wealth taxation. For the highest lifetime income group, median net worth is highly affected by the rise and boom of financial markets and the housing markets. Regarding the older cohorts (age 75+), we observe that net worth already starts to decline before the financial crisis. This provides suggestive evidence that the richest households start drawing down their wealth after reaching age 75.

These asset profiles stratified by lifetime income are completely different compared to the asset profiles in the US, as shown by De Nardi et al. (2010) for single-person households for the years 1996 to 2006. First of all, there is more variation in median net

worth among the income quantiles in the US, compared with the Netherlands: In the US, the bottom income group has virtually no assets, while the middle income group has substantially higher assets. Second, in contrast to households in the Netherlands, US households with high incomes see net worth rise with age. The opposite is the case for households with low income. De Nardi et al. (2010) explain the observed patterns by out-of-pocket health expenses, which are unimportant for the Netherlands. The asset profiles might also be different because of the different periods of analysis with different economic activity. For example, we observe households before and after the downturn of the financial markets in 2008, which significantly affected asset holdings among the high-income group, while De Nardi et al. (2010) observed households in a period of higher economic growth, which might partly explain the rising wealth profile for the high-income groups. The higher prevalence of homeownership in the US might provide another explanation for the different asset patterns.

4.4.7 Financial wealth holdings of homeowners and renters

Homeownership status has an important impact on the wealth distribution among Dutch retirees. If we compare the tenure status in 2005 with the tenure status in 1989, we find that there is a strong persistence in ownership of housing, particularly among individuals in the older age groups. Among the oldest age group, less than 5 percent of the households who lived in a rental home in 1989 became homeowners in 2005. For individuals at the start of retirement, this holds true for about 18 percent. These households did not gain from the large appreciation of housing prices from the beginning of the nineties up to 2007.

Figure 4.5 shows the profile of median net financial wealth among homeowners and non-homeowners (in 2004) for widowed persons. The figure shows that renters are considerably poorer compared to homeowners. Besides the lower accumulated housing equity, they also hold limited financial savings. This might reflect their inability to purchase a house during their working life. The figure provides no clear evidence that elderly homeowners draw down their liquid savings.

4.5 Marital transitions and wealth holdings

We observe that widowed persons have much less wealth than married couples. To understand the differences in the level of wealth between widowed households and couples, we consider the effect of the death of a spouse on wealth holdings and the composition of wealth holdings.

Table 4.8 examines the evolution of private wealth by marital status transition within

two years.[11] We distinguish between three groups: married couples who survive between two waves (married-married); married couples of whom the partner dies in the next period (married-widowed); and widowed persons in two consecutive waves (widowed-widowed).

First, notice the significant difference in wealth between married couples who survive and those who lose a partner in the next period. Mean net worth of surviving couples in the age group 65-74 is € 260,100 in 2005 and € 280,200 in 2007, while net worth of couples of which the partner dies in the next period is € 191,900 in 2005 and € 245,200 in 2007. Similarly, persons who become widowed at older ages (age group 75+) are wealthier compared to those who lost their partner at an earlier age. This results in a lower level of net worth for widowed persons among all age groups.[12] The difference is caused by the survival of wealthier couples.

In addition to differential mortality, there is a direct effect of widowhood on net worth. The effect of the death of a spouse on wealth holdings can be seen by comparing net worth in the period before and (one year) after the death of the spouse. For married couples in the age group 75 or older of whom the spouse dies within the next year, mean net worth is € 222,900 in 2005 and declines by 9.8 percent to € 201,000 in the year after the death of the spouse. To interpret the magnitude of the effect of widowhood, we compare the change in net worth between surviving couples and couples in which the spouse dies in the same period. Net worth of surviving couples increases between 2005 and 2007 by 5.3 percent to € 266,700 in 2007. The relative decline in net worth due to bereavements is thus 15.1 percent (i.e. difference between -9.8 and +5.3). For the period between 2007 and 2009, net worth declines by 9.1 percent among surviving couples. Wealth declines much faster when there is bereavement. For couples who lose their spouse, mean net worth declines by 37.8 percent. We thus find a similar net effect as in the years 2005 and 2007. For net financial wealth we even find a somewhat larger drop, presumably because this is more liquid compared to housing wealth. An explanation for the drop in financial wealth after the death of the spouse may include transfers to the children or estate taxes. In addition, wealth holdings might be lower if the collected assets from the sale of the house are less than the valuation of the owner-occupied house. Poterba et al. (2011) find less explicit effects for financial assets but strong effects for housing equity. Sheiner and Weil (1992) and Feinstein and McFadden (1989) also show that the decease of a partner is an important determinant of housing turnover.

[11] We examine the change in wealth holdings between wave t and wave $t+2$.

[12] The observation that widowhood at an early age is associated with lower net worth is also illustrated by the difference in net worth between continuing couples in 2005 and 2007, where mean net worth is € 276,600 in 2007, and couples who are alive in 2007 and 2009, where mean net worth is € 290,200 in 2007.

We find that widowhood results in a significant decline in homeownership in the years after the financial crisis, but not in the period before the financial crisis; see Table 4.9. A possible explanation for this asymmetric effect is that widowed persons decide to sell the house sooner if future prospects about the housing market are poor or because the supply of suitable housing is larger. Moreover, it might be more likely that the children demand their statutory portion (of the estate) if economic prospects are poor, which results in the sale of the house. In addition, we observe a significant reduction in ownership of risky assets among widowed households compared to surviving couples (observing not only the ownership rate but also the average portfolio share). In contrast to housing equity, the effect of widowhood on risky assets is much stronger in the years before the financial crisis. These opposite effects of risky assets and housing equity might explain why there is no clear-cut effect of widowhood on the share of savings in checking and savings accounts.

The observation that widowhood is associated with a reduction in the portfolio share and ownership of risky assets is not in line with Coile and Milligan (2009), who find that widowhood increases the share of assets held in liquid financial assets such as stocks and mutual funds (but also checking and savings accounts) and reduces the share of assets held in illiquid assets such as housing. This suggests that widowed persons prefer liquid household portfolios (to pay for health expenditures, for example). Our results indicate that widowed persons prefer less complex and less risky household portfolios. Whether they sell their house or stocks depends on the economic situation. The liquidity consideration might be less relevant in the Netherlands.

4.6 Health status, wealth holdings and financial portfolios

We have shown above that widowhood at an early age is associated with lower wealth. In addition, persons with low lifetime income often have little wealth holdings. This suggests that health differences are important in explaining the financial status of the elderly: health problems in working life reduce the ability to work, which leads to lower pensions and less private savings; in retirement, these health problems lead to early death. For example, Smith (2004) shows for US households that the unfolding of a major health event leads to a large cumulative loss in income and consequently less wealth accumulation and reduced pensions.

There are other ways in which health status affects economic resources after retirement. A new health problem might lead to sizable out-of-pocket medical expenses, which reduce savings in case of limited insurance coverage. In addition, health status

might affect the level of non-medical consumption. Finally, health shocks might reduce the expected remaining lifetime. This reduces the marginal utility of holding wealth in the absence of a bequest motive. Wealth holdings are not affected through reduced income in retirement, since all retirees have a certain pension income. However, as already indicated, both pension income and wealth holdings might be adversely affected by pre-existing health problems before retirement.

Since the analysis is at the household level, we account for the health status of both partners in a household. Table 4.10 shows the association between health status and wealth holdings for different combinations of health and different age groups. The table shows that there is a strong association between wealth holdings and health for both the median and mean. For example, a couple between the ages of 75 and 79 with no previous health problems has an average net worth of € 237,500, while a couple of which one or both partners has major health problems has a net worth of € 210,000. This difference can mainly be attributed to differences in homeownership status between households with a different health status, as reported in the final column. Homeownership among households aged 75-79 with no preexisting health problems is 46.0 percent, while homeownership among couples with major health problems is 38.2 percent. The strong association between health and financial resources, among other things, is found by Poterba et al. (2011), among others. Their study also shows that households in good health have rising wealth profiles in retirement, while unhealthy households have a very flat wealth profile.

Next, we examine whether the onset of a new major disease (cancer or cardiovascular disease) affects wealth holdings between two waves. To analyze the effect of a new health event on wealth, we control for initial health status. We compare households who had no health problems (of any household member) between 2003 and 2005 but experienced different health shocks thereafter. We distinguish between five groups (see Figure 4.6). The healthy group (dashed line) experienced no health shock (of any member) between 2005 and 2009 and serves as reference group. The other groups experienced a health shock (of at least one member) between 2005 and 2009 that differs in severity: the second group (dotted line) experienced a minor health shock (of at least one member) between 2005 and 2007 and is readmitted to the hospital for a minor condition between 2007 and 2009; the third group (thick line) experienced a minor health shock (of at least one member) between 2005 and 2007 and a severe health shock between 2007 and 2009; the fourth group (thick dashed line) experiences a severe health shock (of at least one member) between 2005 and 2007 and is readmitted to the hospital for a similar severe condition between 2007 and 2009; the final group (thin line) experienced a health shock (of at least one member) between 2005 and 2007 and one of the members dies in 2010 (not necessarily for the same cause).

Figure 4.6 shows that there are significant differences in the level of net worth, depending on health status: households experiencing a severe health shock are somewhat poorer, compared to households who experienced a minor health shock or no health shock. The slopes of the lines are very similar, which implies that there is no differential effect of health on mean net worth. When we look at homeownership we do not observe a clear effect of health on the change in homeownership status. Health problems might deter individuals from moving, due to the high physical and psychological burden of moving. Older people might already have moved in anticipation of getting health problems in the near future. Since elderly persons do not move house after the onset of a health event, it is relevant to analyze the effect of health on financial assets. For net financial wealth we also observe the initial differences in net financial wealth among different health groups. Notice that the level of net financial wealth eventually diverges in 2009 for all groups (except for the group of whom one of the members dies in 2010). This implies that those groups who experience a severe health shock accumulate relatively more financial wealth than those who stay in good health.

These results do not match the US evidence, as provided by Poterba et al. (2011), that households with health problems accumulate less wealth than healthy households. Possible explanations are the comprehensive health insurance system in the Netherlands and the relatively high replacement rates in the Netherlands, which guarantee a relatively constant standard of living; see, for example, García-Gómez et al. (2013). Another possibility is a decline in the marginal utility of consumption after a health shock, which results in more savings.

4.6.1 Household wealth before nursing home entry

Long-term care expenditures account for approximately 25.5 percent of health expenditures and 2.9 percent of GDP in 2012. These expenditures are almost completely covered by the Exceptional Medical Expenses Act (AWBZ), the public long-term care insurance program (CBS, 2012). The projected growth of LTC expenditures puts further pressure on the fiscal budget. As a result, there is growing interest in requiring persons to use their own resources to pay for LTC. LTC services are costly, however, and may require substantial savings.

The most expensive form of LTC is nursing home use. The risk of entering a nursing home is very high: about one-third of the persons over age 65 spent at least one night in a nursing home between 2004 and 2011. The incidence of nursing home entry is particularly high at advanced old age; only one-third of persons aged 85 years and older in 2004 did not stay in a nursing home; see Table 4.11.

The time that a person spends in a nursing home is distributed very unevenly, which

makes total expenditures on LTC uncertain. LTC institutions receive a fixed payment for each patient, depending on the severity of the patient's needs. The payment ranges from € 65 a day for patients with lighter LTC needs, to € 270 a day for patients who are nearing the end of life and have serious LTC needs. A year's stay in a nursing home cost, on average, € 58,500 in 2012 (CIZ & NZA 2012). This implies that individuals need almost € 300,000 in financial resources to finance a five-year stay in a nursing home. In particular, with regard to individuals diagnosed with degenerative diseases such as dementia, it is not unlikely that they will spend an enduring period in a nursing home; see e.g. Hurd et al. (2013). In the Netherlands, roughly 30 percent of the nursing home population has dementia or related disorders (CIZ, 2012).

Only a small fraction of the elderly would be able to finance nursing home expenditures out-of-pocket using their income and net worth. Table 4.12 reports the distribution of total resources of single elderly in the year before they permanently enter a nursing home. These resources are in theory available to fund LTC costs. For the vast majority, pension income is well under the amount required to cover these costs. A somewhat larger group would be able to self-support a nursing home stay if they would draw down their private savings. Table 4.13 shows the maximum number of years of nursing home use that these persons would be able to finance from their private resources; we assume that the costs of LTC move in line with asset prices and that there are no transaction costs involved with selling the house. Only 40 percent of nursing home residents would be able to pay out-of-pocket a nursing home stay of more than one year; only 20 percent of the residents would be able to finance a nursing home stay of more than five years. This group consists primarily of homeowners.

This calculation does not even take into account the possible use of home care services prior to entering a nursing home. Although the cost of receiving nursing care or personal care at home is somewhat less expensive, the likelihood of receiving home care is very high; see Table 4.11.

4.7 Savings during the last years of life

We find that the elderly, on average, keep large amounts of assets even at a very old age and do not decumulate assets. In the absence of a bequest motive, they might hold these assets because of uncertainty about the time of death or uncertain expenses in the last years of life. In that case, we should find that households start drawing down their money in the last phase of life and this holds in particular for individuals in poor health who have a lower life expectancy.

Table 4.14 reports wealth levels in the first wave (2005) and final wave (2010) for single households with no pre-existing health problems. The first set of columns of the table

shows the trajectory of wealth holdings for individuals who do not die between 2005 and 2011. The second set of columns shows the trajectory of wealth for individuals who die between 2005 and 2011. These columns indicate that assets decline in the reporting period. However, there is no difference in the decline between both groups. The table also shows the same analysis for single households with major pre-existing health problems before 2005. The table indicates that there is differential mortality between both groups. There is no evidence of dissaving in the years before death.

It seems that individuals in poor health save during the last years of life. These results are not in line with evidence from US studies, which find a large decline in assets in late-life (e.g. French et al., 2006). Poterba et al. (2014) show that the decline in assets at the end of life is strongly associated with deteriorating health and not caused by an underestimation of life expectancy or lower pension benefits. This suggests that medical expenditure risk is not important in the Netherlands and that a bequest motive might be relevant.

4.8 Conclusion

The elderly, on average, keep large amounts of assets even at a very old age, and they leave a considerable bequest. We do not find evidence of decumulation of wealth after retirement for singles, despite the fact that retirees face limited income uncertainty and limited uncertainty about out-of-pocket payments for medical expenses. We find some suggestive evidence of dissaving for high-income widowed persons.

At the median, we observe that the elderly have accumulated a decent buffer of financial wealth, high enough to cover small unexpected expenses but too small to significantly increase consumption in retirement. These households depend mainly on social security and pension income to support retirement consumption.

Our results also show that not many homeowners sell off their house to finance their retirement, and it is very likely that homeownership among the elderly will increase in the future because of cohort effects. There is some suggestive evidence that younger elderly persons extract housing equity by means of interest-only mortgages.

There are large initial differences in the level of wealth holdings among different health groups and between couples and singles. The latter is most likely related to the socioeconomic status of households, since we do not find major differences in the decumulation pattern for different health groups. The onset of a newly diagnosed severe health condition even results in increased savings in financial assets. A possible explanation for this finding is that deteriorating health constrains non-health-care consumption. Persons in bad health are no longer able to travel or to enjoy leisure activities and they consume less food. It is questionable whether people take this declining consumption path into

account when planning for retirement. This results in higher savings in old-age.

The bereavement of a spouse results in a significant reduction of net worth compared to surviving couples, in both the period before and after the financial crisis. We also observe a slight reduction in homeownership after the death of a spouse (in the years after the financial crisis) and a significant reduction in the ownership rate and portfolio share of risky assets (in the years before the financial crisis). The reduction in homeownership indicates that people downsize their housing wealth when they become widowed. The collected assets from the sale of the house might partly be transferred to the heirs, resulting in a drop in net worth. Not surprisingly, we find strong evidence of differential mortality, which also explains the differences in household portfolios between widowed persons and married couples.

It can be concluded that a simple life-cycle model is soundly rejected. To explain the saving behavior of the elderly, it is important to consider extended versions of this basic model that explicitly take into account not only a bequest motive, but also the role of lifetime uncertainty, housing, family structures and (wealth and estate) tax-rules. In addition, it is important to allow for health-dependent utility. It is unclear whether the observed large bequests are intended or accidental. Data on the economic status of the children and the exact division of the estate among the heirs might allow us to approach this important research question in future research.

4.9 Tables and figures

Table 4.1: Household wealth in 2005 by marital status (cross section), in thousands of euros and in 2010 prices

Wealth and age group	Married couple				Widowed				Never-married			
	N	Own (%)	Mean	Median	N	Own (%)	Mean	Median	N	Own (%)	Mean	Median
Net Worth												
Age 65 to 69	1331	96.7	267.4	158.6	369	91.6	193.6	41.6	390	84.6	139.1	13.7
Age 70 to 74	1591	97.9	242.8	136.7	569	90.7	150.5	24.9	321	91.6	184.0	20.0
Age 75 to 79	1226	98.4	235.3	99.8	777	93.3	142.2	24.9	217	93.1	188.2	24.3
Age 80 to 84	687	98.7	248.0	87.5	734	94.8	168.9	24.9	159	96.2	283.8	62.1
Age 85+	212	98.6	239.1	66.7	600	94.5	156.5	24.9	97	92.8	207.8	24.9
Net Financial Wealth												
Age 65 to 69	1331	95.9	118.8	30.1	369	88.9	78.1	17.2	390	84.4	69.0	9.5
Age 70 to 74	1591	97.0	108.5	33.1	569	89.1	52.9	16.2	321	91.9	101.8	17.7
Age 75 to 79	1226	97.9	107.3	37.2	777	91.6	68.1	20.2	217	92.2	111.8	15.5
Age 80 to 84	687	97.7	128.1	42.5	734	94.0	94.2	20.2	159	96.2	198.7	35.9
Age 85+	212	98.6	147.1	46.0	600	93.8	99.6	22.0	97	92.8	146.3	24.9
Housing Equity												
Age 65 to 69	1331	54.9	148.6	103.0	369	40.9	115.4	0.0	390	28.5	70.1	0.0
Age 70 to 74	1591	48.0	134.3	0.0	569	35.0	97.6	0.0	321	27.7	82.2	0.0
Age 75 to 79	1226	42.7	128.0	0.0	777	27.0	74.1	0.0	217	24.4	76.4	0.0
Age 80 to 84	687	38.4	119.9	0.0	734	24.5	74.7	0.0	159	25.8	85.2	0.0
Age 85+	212	30.2	92.0	0.0	600	18.2	56.9	0.0	97	19.6	61.5	0.0
Social Security wealth												
Age 65 to 69	1331	100.0	225.0	232.0	369	94.9	154.9	169.1	390	99.7	142.4	150.7
Age 70 to 74	1591	100.0	196.5	197.5	569	100.0	134.3	135.4	321	99.7	127.3	128.8
Age 75 to 79	1226	99.9	158.3	158.0	777	100.0	103.3	102.9	217	100.0	98.9	97.6
Age 80 to 84	687	100.0	120.3	119.6	734	100.0	75.8	78.5	159	100.0	75.7	78.5
Age 85+	212	100.0	85.0	86.6	600	100.0	45.8	48.0	97	100.0	47.7	50.0
Pension wealth												
Age 65 to 69	1331	96.2	231.8	157.5	369	90.2	113.5	65.3	390	74.9	96.2	47.4
Age 70 to 74	1591	93.8	156.7	107.0	569	88.6	84.8	45.2	321	75.4	76.9	36.2
Age 75 to 79	1226	90.1	116.1	70.7	777	88.3	64.5	37.6	217	72.4	55.5	24.9
Age 80 to 84	687	90.1	86.6	47.2	734	83.8	45.6	22.9	159	71.1	46.3	25.4
Age 85+	212	87.7	58.5	31.4	600	80.2	24.6	9.0	97	60.8	27.2	10.2

Table 4.2: Household wealth by marital status between 2005 and 2010 for households aged 65-69 in 2005 (balanced panel)

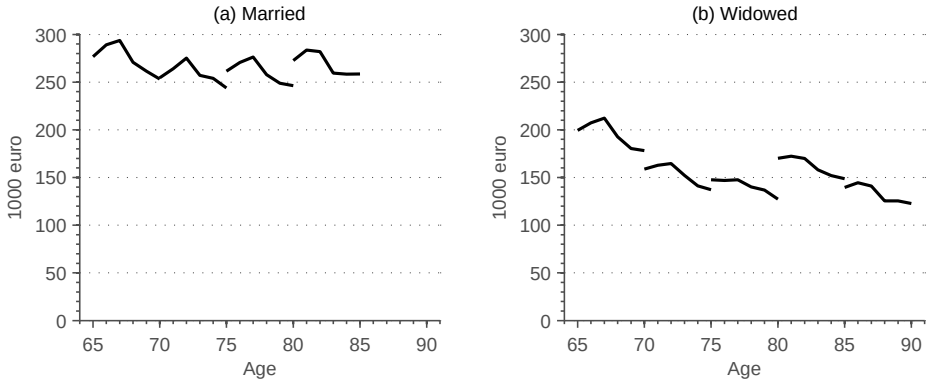
	2005	2006	2007	2008	2009	2010	%Δ '05-'07	%Δ '07-'10
Married (N=1,074)								
Net Worth								
Mean	276.1	289.1	293.6	270.9	261.1	253.3	6.3	-13.7
Median	171.0	184.3	188.4	182.6	179.8	163.5	10.2	-13.2
Mean share net worth*	29.1	29.9	30.5	29.8	30.5	30.6		
Net Financial Wealth								
Mean	121.8	127.5	127.3	110.2	115.0	112.5	4.5	-11.6
Median	31.1	30.8	32.8	32.2	34.5	32.3	5.5	-1.5
Mean share fin wealth	11.4	11.6	11.8	11.5	12.4	12.7		
Housing equity								
Mean	154.3	161.6	166.3	160.6	146.1	140.7	7.8	-15.4
Homeownership rate	57.1	57.6	57.4	57.1	56.8	56.6	0.5	-1.4
Mean share housing eq.	17.7	18.3	18.7	18.3	18.1	17.9		
Widowed (N=320)								
Net Worth								
Mean	199.4	207.2	212.3	192.6	178.7	177.1	6.5	-16.6
Median	46.5	44.3	40.1	35.1	31.9	28.6	-13.8	-28.7
Mean share net worth	28.1	28.0	28.2	27.5	27.0	23.5		
Net Financial Wealth								
Mean	82.4	83.1	87.1	76.3	72.0	74.8	5.7	-14.1
Median	17.7	17.3	18.7	17.6	16.0	16.0	5.6	-14.4
Mean share fin wealth	11.6	10.9	11.0	10.2	10.4	6.3		
Housing equity								
Mean	117.0	124.1	125.2	116.3	106.7	102.3	7.0	-18.3
Homeownership rate	42.2	41.9	41.9	41.3	41.6	41.3	-0.7	-1.4
Mean share housing eq.	16.5	17.1	17.2	17.3	16.6	17.2		

Notes: All amounts are expressed in thousands of euros and in 2010 prices using the CPI deflator. In this table we consider a balanced panel: i.e. the same households are followed over time for which the marital status does not change between 2005 and 2010.

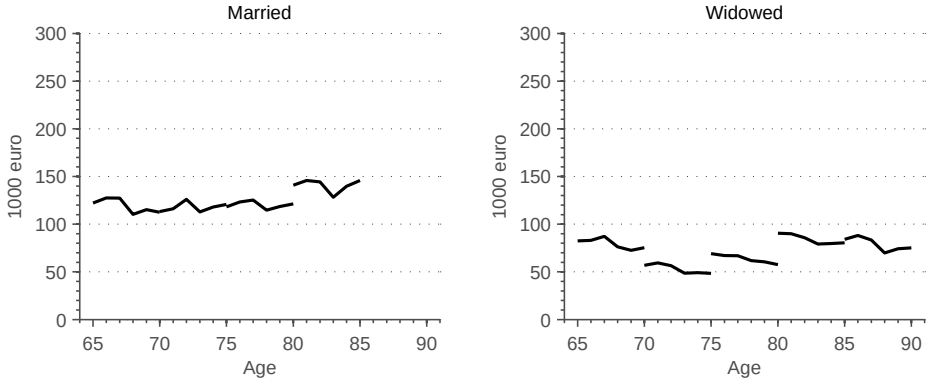
* Mean share of total wealth (%): total wealth is equal to the sum of net worth, social security wealth and pension wealth.

Figure 4.1: Wealth profiles (Mean) by Cohort and Age of the Key person of Household (Balanced Panel)

(a) Net Worth (mean)



(b) Net Financial Wealth (mean)



(c) Housing equity (mean)

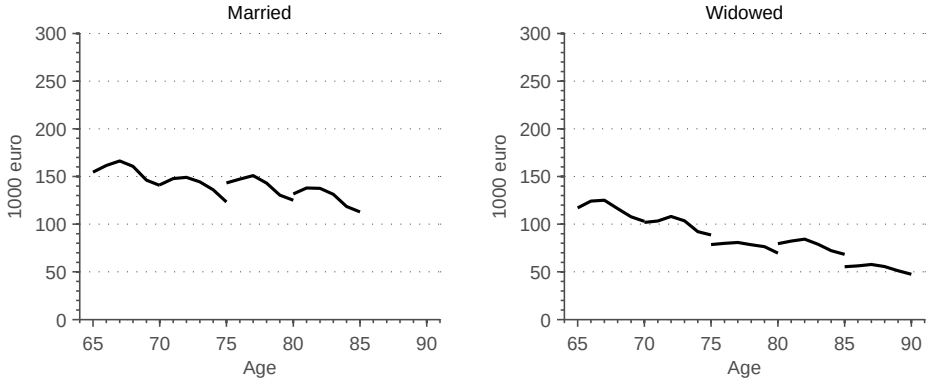
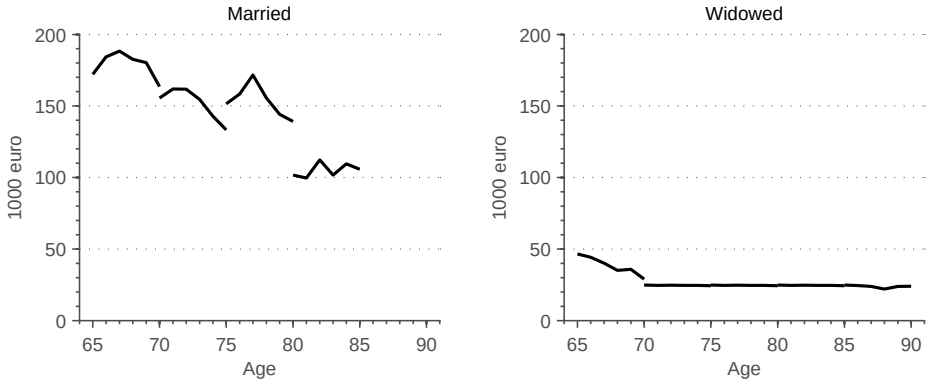
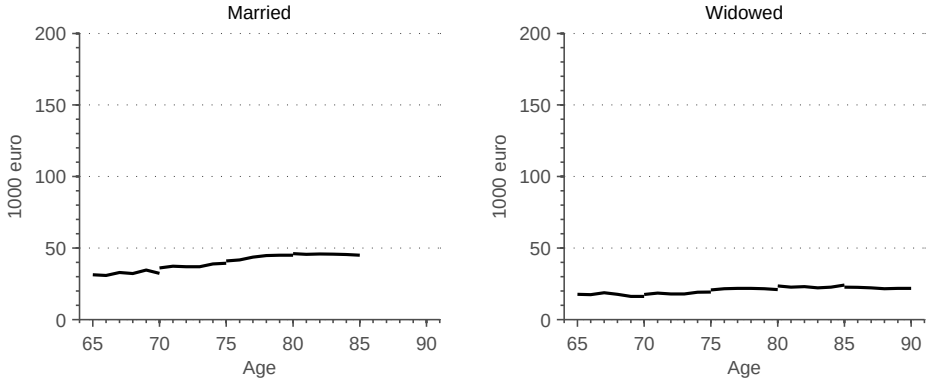


Figure 4.2: Wealth profiles (Median) by Cohort and Age of the Key person of Household (Balanced Panel)

(a) Net Worth (median)



(b) Net Financial Wealth (median)



(c) Housing equity (ownership rate)

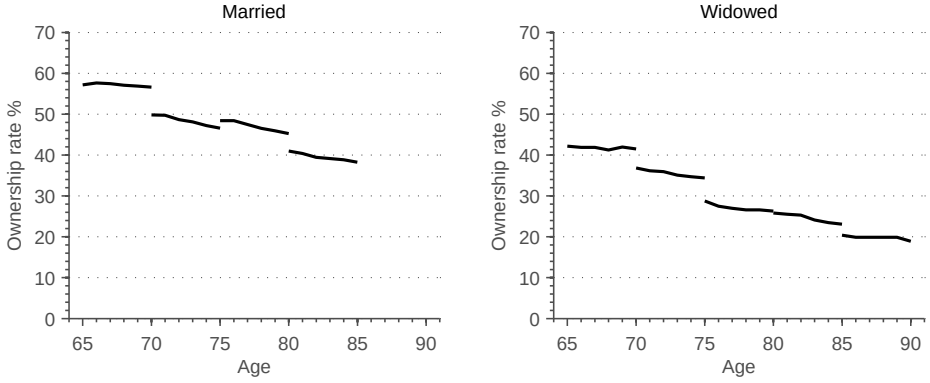


Table 4.3: Household portfolios by marital status and age in 2005

	Married couple				Widowed person			
Asset (debt) item	N	Mean	Own (%)*	Share (%)†	N	Mean	Own	Share (%)
Age 65 to 69								
Checking/savings accounts	1331	51.4	96.2	47.0	369	35.4	89.7	56.7
Risky assets		50.2	29.5	5.5		21.4	21.4	5.0
House		179.7	55.6	44.2		132.5	41.2	34.8
Other assets		24.1	14.2	3.3		27.5	11.9	3.5
Mortgage		31.1	35.7	8.5		17.1	24.9	4.8
Other debts		6.9	7.5	1.8		6.1	7.9	1.1
Loan-to-value ratio‡		18.3				13.9		
Age 70 to 74								
Checking/savings accounts	1591	53.2	97.5	54.0	569	30.3	89.6	62.1
Risky assets		39.4	26.6	5.5		18.4	18.3	4.8
House		152.7	48.6	37.6		109.4	35.1	31.2
Other assets		19.4	14.2	2.9		8.5	7.9	1.9
Mortgage		18.4	26.5	4.9		11.9	19.5	3.4
Other debts		3.6	6.1	1.3		4.3	4.7	0.7
Loan-to-value ratio		12.6				10.6		
Age 75 to 79								
Checking/savings accounts	1226	54.8	97.9	57.9	777	35.4	91.8	68.9
Risky assets		37.5	26.3	7.1		22.2	16.9	5.1
House		140.5	42.9	32.1		81.0	27.0	22.3
Other assets		18.4	13.4	2.8		14.5	10.0	3.7
Mortgage		12.5	18.5	3.5		6.9	10.8	2.1
Other debts		3.4	4.3	0.4		4.0	4.4	1.0
Loan-to-value ratio		9.7				8.7		
Age 80 to 84								
Checking/savings accounts	687	65.3	97.8	63.0	734	46.5	94.1	72.2
Risky assets		50.9	25.0	7.1		33.9	16.9	6.2
House		129.4	38.7	27.2		78.2	24.7	18.9
Other assets		15.3	14.1	2.7		18.2	10.6	2.7
Mortgage		9.5	13.4	2.4		3.5	6.8	1.3
Other debts		3.4	4.7	0.5		4.3	4.1	0.8
Loan-to-value ratio		8.3				5.8		
Age 85+								
Checking/savings accounts	212	79.7	98.6	68.3	600	49.1	94.0	77.3
Risky assets		50.5	25.5	9.0		40.5	13.7	6.0
House		96.9	30.2	19.2		57.6	18.2	13.1
Other assets		18.7	15.6	3.5		15.6	11.0	3.6
Mortgage		4.8	7.1	1.4		0.8	2.5	0.2
Other debts		1.8	6.1	0.3		5.6	4.3	0.7
Loan-to-value ratio		6.3				1.3		

Notes: All amounts are expressed in thousands of euros and in 2010 prices using the CPI deflator. * The column 'Own (%)' reports the ownership rate of the asset (debt) item.
† The column 'share (%)' reports the average portfolio share of each asset (debt) item in 'total assets'. Total assets is the sum of checking and savings accounts, risky assets, the value of the primary residence (house) and other assets.
‡ The rows headed 'loan-to-value' report the average of the loan-to-value ratio.

Table 4.4: Household portfolios by net worth quartiles and age in 2005 - Married couples

Asset (debt) item	Ownership rate (%)				Portfolio share (%))			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Age 65 to 69								
Checking/savings accounts	88.6	99.1	97.6	99.7	96.1	67.8	13.9	15.6
Risky assets	3.6	21.3	27.0	66.3	1.3	5.6	2.4	12.1
House	2.4	28.2	95.5	96.4	2.4	25.3	81.0	63.4
Other assets	0.9	3.0	10.8	42.2	0.1	1.3	2.7	8.9
Mortgage	2.7	25.8	66.7	47.6	3.1	11.1	12.8	6.2
Other debts	1.5	4.8	7.8	16.0	4.7	0.9	0.9	1.1
Age 70 to 74								
Checking/savings accounts	92.0	99.7	98.7	99.7	97.5	84.2	19.7	17.9
Risky assets	4.3	17.3	25.1	59.7	1.5	4.9	4.2	10.9
House	1.0	10.8	86.9	95.7	0.9	9.8	72.7	64.2
Other assets	0.5	4.3	12.8	39.3	0.0	1.1	3.4	7.0
Mortgage	1.0	10.3	56.0	38.8	1.2	4.4	8.8	5.1
Other debts	0.8	1.3	6.3	16.1	3.4	0.3	0.6	0.9
Age 75 to 79								
Checking/savings accounts	93.8	99.3	98.7	99.7	97.7	89.0	29.1	18.3
Risky assets	3.9	17.0	27.4	56.9	1.9	7.1	6.5	12.6
House	0.3	3.3	73.6	94.4	0.3	2.9	61.6	61.8
Other assets	0.0	2.3	12.4	38.9	0.0	1.0	2.8	7.3
Mortgage	0.3	2.6	42.0	29.1	0.4	1.5	9.0	2.8
Other debts	0.3	1.6	3.3	12.1	0.0	0.4	0.3	0.8
Age 80 to 84								
Checking/savings accounts	94.8	99.4	97.7	99.4	99.6	95.2	38.4	20.3
Risky assets	1.7	12.8	27.3	58.5	0.3	4.2	8.0	15.7
House	0.0	0.0	62.2	93.0	0.0	0.0	49.9	57.8
Other assets	0.6	2.3	14.0	39.8	0.1	0.6	3.7	6.2
Mortgage	0.0	0.0	32.0	21.6	0.0	0.0	7.0	2.3
Other debts	0.0	0.6	4.7	13.5	0.0	0.1	0.8	1.0
Age 85+								
Checking/savings accounts	94.3	100.0	100.0	100.0	99.4	93.4	55.3	26.8
Risky assets	0.0	7.5	34.0	60.4	0.0	4.5	10.0	21.1
House	0.0	0.0	39.6	81.1	0.0	0.0	30.3	45.2
Other assets	1.9	3.8	17.0	39.6	0.6	2.1	4.4	6.9
Mortgage	0.0	0.0	17.0	11.3	0.0	0.0	4.7	0.8
Other debts	0.0	1.9	3.8	18.9	0.0	0.1	0.1	0.9

Notes: The left-hand panel of this table reports the ownership rates (%) of each asset (debt) item; the right-hand panel of this table reports the average portfolio share of each asset (debt) item in 'total assets'. Total assets is the sum of checking and savings accounts, risky assets, the value of the primary residence (house) and other assets.

Table 4.5: Household portfolios by net worth quartiles and age in 2005 - Widowed persons

Asset (debt) items	Ownership rate (%)				Portfolio share (%)			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Age 65 to 69								
Checking/savings accounts	66.7	100.0	93.5	98.9	100.0	97.4	29.2	14.3
Risky assets	0.0	7.6	30.4	47.8	0.0	2.6	7.0	8.7
House	0.0	0.0	68.5	96.7	0.0	0.0	59.1	68.8
Other assets	0.0	0.0	14.1	33.7	0.0	0.0	4.7	8.2
Mortgage	0.0	0.0	51.1	48.9	0.0	0.0	12.0	5.5
Other debts	0.0	0.0	9.8	21.7	0.0	0.0	2.1	2.0
Age 70 to 74								
Checking/savings accounts	62.9	100.0	96.8	98.6	100.0	97.7	42.8	14.7
Risky assets	0.0	6.3	21.8	47.2	0.0	2.3	7.5	8.5
House	0.0	0.0	52.4	95.1	0.0	0.0	46.9	72.3
Other assets	0.0	0.0	9.7	23.2	0.0	0.0	2.8	4.5
Mortgage	0.0	0.0	41.1	42.3	0.0	0.0	8.5	5.1
Other debts	0.0	0.0	5.6	14.1	0.0	0.0	1.1	1.7
Age 75 to 79								
Checking/savings accounts	73.3	100.0	95.9	97.4	99.5	98.6	66.3	15.4
Risky assets	0.5	4.6	27.1	38.1	0.5	1.4	9.2	9.2
House	0.0	0.0	21.2	89.7	0.0	0.0	18.6	66.9
Other assets	0.0	0.0	12.9	28.9	0.0	0.0	6.0	8.5
Mortgage	0.0	0.0	15.3	29.9	0.0	0.0	4.1	4.3
Other debts	0.0	0.5	4.1	13.4	0.0	0.2	1.4	2.2
Age 80 to 84								
Checking/savings accounts	79.3	100.0	100.0	97.3	99.4	97.0	69.6	21.5
Risky assets	0.0	6.6	22.5	42.6	0.0	3.0	9.5	12.7
House	0.5	0.0	17.4	85.2	0.6	0.0	15.5	59.7
Other assets	0.0	0.0	15.2	31.1	0.0	0.0	5.5	6.1
Mortgage	0.5	0.0	10.1	19.1	0.9	0.0	3.1	1.9
Other debts	0.5	0.0	7.2	10.4	0.5	0.0	2.0	1.3
Age 85+								
Checking/savings accounts	78.0	100.0	100.0	98.0	99.8	99.3	83.0	25.9
Risky assets	0.7	3.4	10.8	42.7	0.2	0.7	5.9	17.9
House	0.0	0.0	1.1	72.0	0.0	0.0	0.9	49.1
Other assets	0.0	0.5	20.4	30.7	0.0	0.0	10.2	7.1
Mortgage	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.7
Other debts	0.0	0.5	3.2	14.7	0.0	0.2	0.4	2.3

Notes: The left-hand panel of this table reports the ownership rates (%) of each asset (debt) item; the right-hand panel of this table reports the average portfolio share of each asset (debt) item in 'total assets'. Total assets is the sum of checking and savings accounts, risky assets, the value of the primary residence (house), and other assets.

Table 4.6: Household portfolios between 2005 and 2010, age 65-69 in 2005, balanced panel

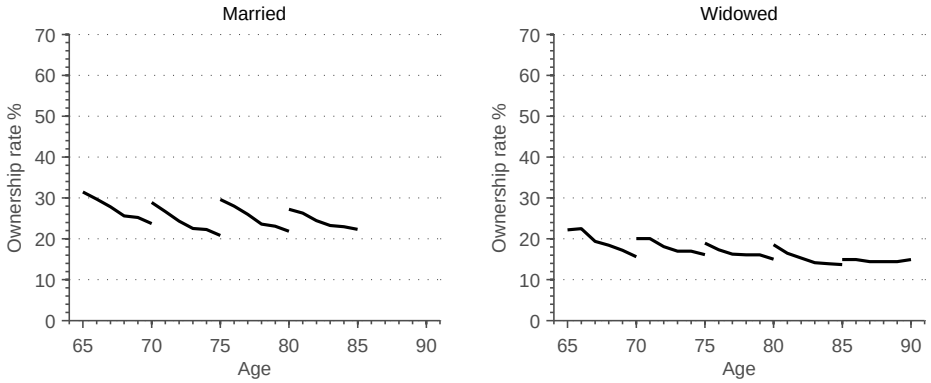
	2005	2006	2007	2008	2009	2010	Δ '05 - '07	Δ '07 - '10
Married (N=1074)								
Ownership rate (%)								
Checking/savings accounts	96.9	96.0	98.1	97.3	98.6	97.9	1.2	-0.2
Risky assets	31.5	29.7	27.8	25.6	25.2	23.7	-13.3	-14.7
House	57.9	58.2	57.8	57.7	57.5	57.5	-0.2	-0.5
Other assets	14.6	14.9	14.2	13.7	14.5	12.8	-2.8	-9.9
Mortgage	37.7	37.8	37.2	36.3	35.2	34.2	-1.3	-8.1
Other debts	7.7	7.2	7.7	7.2	7.2	7.0	0.0	-9.1
Loan-to-value ratio	19.1	19.0	18.0	18.6	19.5	20.0	-6.1	11.1
*Mean portfolio share (%)**								
Checking/savings accounts	55.0	56.0	56.9	56.8	59.1	59.9	3.3	5.3
Risky assets	5.6	5.5	5.0	4.2	4.2	3.5	-12.0	-30.0
House	36.1	35.4	35.1	35.7	33.8	34.0	-2.8	-3.1
Other assets	3.4	3.2	2.9	3.4	2.9	2.7	-17.2	-6.9
Mortgage	4.9	4.4	4.5	4.6	4.7	4.7	-8.9	4.4
Other debts	1.0	0.9	0.7	1.0	1.6	1.1	-42.9	57.1
Widowed (N=320)								
Ownership rate (%)								
Checking/savings accounts	89.1	91.6	93.1	90.6	94.1	93.1	4.3	0.0
Risky assets	22.2	22.5	19.4	18.4	17.2	15.6	-14.4	-19.6
House	42.5	42.2	42.2	41.6	41.6	41.3	-0.7	-2.1
Other assets	11.9	10.6	10.0	9.4	8.1	8.1	-19.0	-19.0
Mortgage	25.6	24.1	24.4	22.8	21.9	20.9	-4.9	-14.3
Other debts	7.8	8.4	5.6	5.0	7.2	5.3	-39.3	-5.4
Loan-to-value ratio	13.8	13.0	12.4	12.4	13.3	13.2	-11.3	6.5
Mean portfolio share (%)								
Checking/savings accounts	45.0	44.1	46.0	46.6	47.8	48.3	2.2	5.0
Risky assets	5.9	5.9	5.2	3.9	3.9	3.7	-13.5	-28.8
House	46.0	46.7	45.6	46.2	44.4	44.3	-0.9	-2.9
Other assets	3.2	3.3	3.2	3.3	3.8	3.6	0.0	12.5
Mortgage	9.2	9.6	10.3	9.2	9.0	9.4	10.7	-8.7
Other debts	2.0	2.4	10.5	18.4	21.8	7.0	81.0	-33.3

Notes: In this table we consider a balanced panel: i.e. the same households are followed over time for which the marital status does not change between 2005 and 2010.

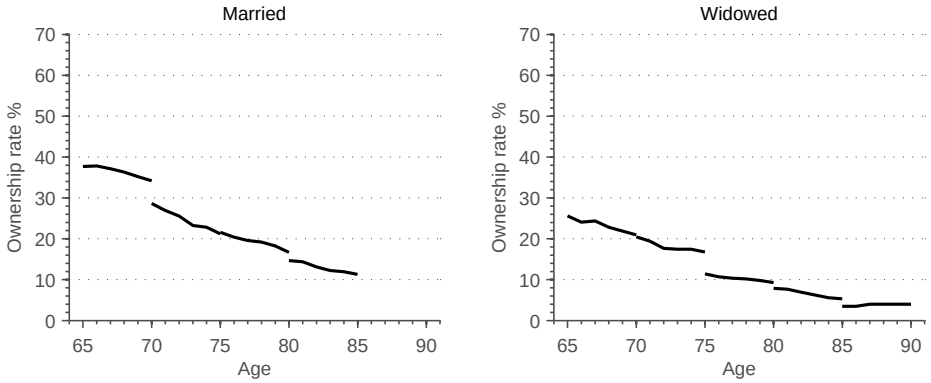
* 'Mean portfolio share (%)' reports the average portfolio share of each asset (debt) item in 'total assets'. Total assets is the sum of checking and savings accounts, risky assets, the value of the primary residence (house) and other assets.

Figure 4.3: Asset ownership by Cohort and Age of the Key person of Household (Balanced Panel)

(a) Risky assets (ownership rate)



(b) Mortgage (ownership rate)



(c) Loan-to-value ratio (mean)

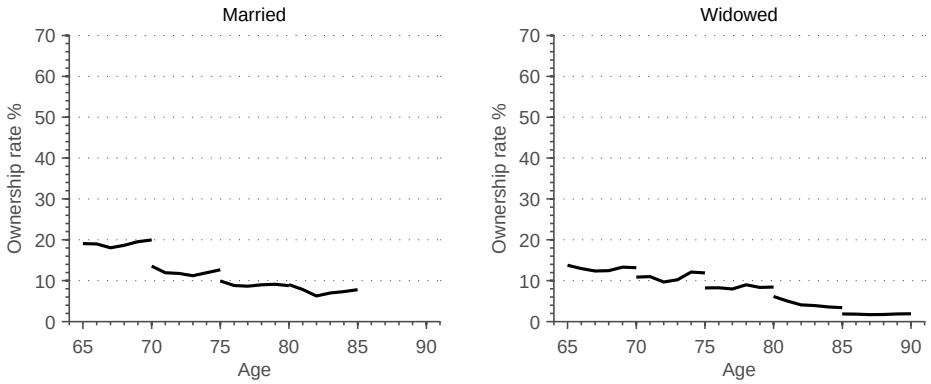


Table 4.7: Household wealth in 2005 by age, marital status and by tertiles of the permanent income distribution

	Married						Widowed					
	Mean			Median			Mean			Median		
	Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q3	Q1	Q2	Q3
Net Worth												
65 to 69	96.2	172.9	533.7	19.6	117.8	372.7	137.2	115.3	328.2	7.8	20.3	244.6
70 to 74	116.6	158.4	453.6	24.1	53.5	326.7	86.8	75.9	289.5	12.9	15.6	211.0
75 to 79	146.5	145.4	414.4	39.4	44.5	307.5	76.5	77.5	272.7	16.2	21.1	152.2
80 to 85	122.7	139.5	481.9	39.4	40.1	357.0	83.4	80.8	343.4	14.2	17.6	182.0
85+	134.9	125.4	460.3	25.5	46.0	291.0	48.4	70.7	350.3	15.1	21.2	109.3
Net Financial Wealth												
65 to 69	32.2	52.8	271.9	10.2	28.4	92.4	77.5	40.9	116.1	6.0	12.9	39.3
70 to 74	46.4	55.7	223.6	15.8	27.9	79.5	30.7	24.7	103.7	7.7	13.7	34.7
75 to 79	68.5	65.4	188.2	21.2	29.4	80.0	41.6	34.4	128.3	12.3	17.4	35.5
80 to 85	59.9	60.8	263.7	26.4	32.9	120.5	49.5	38.0	195.6	12.4	16.7	45.7
85+	72.5	72.7	298.3	25.0	44.6	135.3	35.4	30.7	232.7	14.5	20.1	50.6
Housing Equity												
65 to 69	64.0	120.2	261.8	0.0	51.8	255.6	59.8	74.4	212.2	0.0	0.0	185.8
70 to 74	70.2	102.7	230.1	0.0	0.0	222.7	56.1	51.2	185.8	0.0	0.0	162.3
75 to 79	78.1	79.9	226.2	0.0	0.0	206.7	34.9	43.0	144.4	0.0	0.0	0.0
80 to 85	62.7	78.7	218.2	0.0	0.0	211.1	33.8	42.8	147.8	0.0	0.0	0.0
85+	62.4	52.7	162.0	0.0	0.0	0.0	13.0	40.0	117.6	0.0	0.0	0.0

Notes: All amounts are expressed in thousands of euros and in 2010 prices using the CPI deflator. * Permanent income is defined as the average of the sum of pension and social security income between 2005 and 2010. We formulate permanent income quantiles for both widows and married couples among age groups.

Figure 4.4: Net Worth Profile (median) by Cohort and Permanent Income Tertile for Singles, Balanced Panel

Figure 4.5: Net Financial Assets Profile (median) by Cohort and Homeownership status for Singles, Balanced Panel

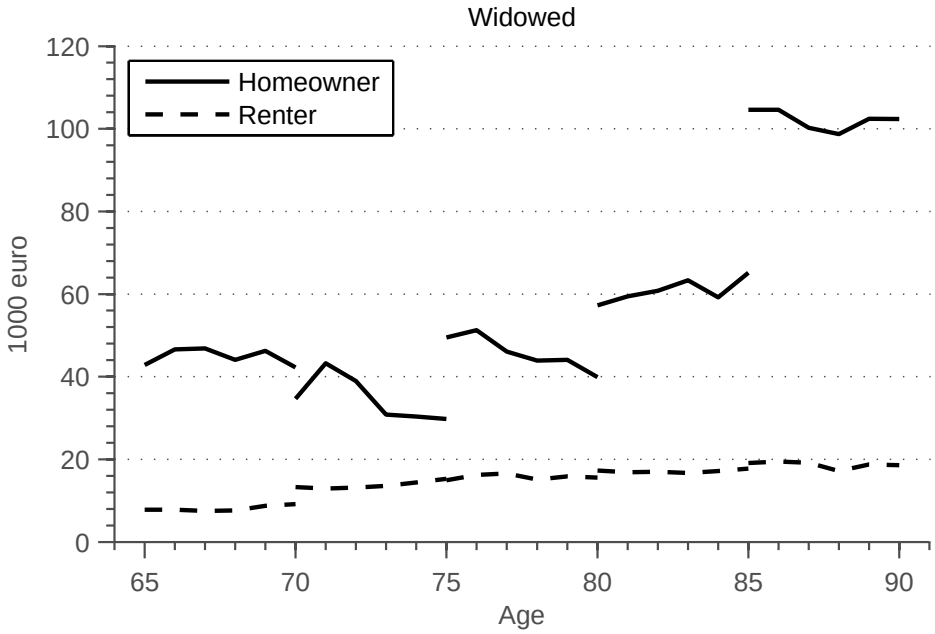


Table 4.8: Marital status transition and wealth changes by year-of-birth cohort, in thousands of euros and in 2010 prices

	Mean						Median					
	t	$t+2$	%Δ	t	$t+2$	%Δ	t	$t+2$	% Δ	t	$t+2$	% Δ
	2005	2007		2007	2009		2005	2007	% Δ	2007	2009	% Δ
Net Worth												
Aged 65-74 in 2005												
Widowed to widowed	175.5	184.2	5.0	184.5	158.0	-14.4	27.9	27.8	-0.4	31.5	29.2	-7.3
Married to widowed	191.9	192.0	0.0	245.2	196.9	-19.7	59.7	60.2	0.8	180.1	130.1	-27.8
Married to married	260.1	276.6	6.3	280.2	252.3	-10.0	159.2	171.1	7.5	174.4	151.4	-13.2
Aged 75+ in 2005												
Widowed to widowed	154.2	154.6	0.3	157.3	141.0	-10.4	24.9	24.7	-0.8	24.7	24.5	-0.8
Married to widowed	222.9	201.0	-9.8	186.6	116.1	-37.8	47.4	74.2	56.5	71.5	36.5	-49.0
Married to married	253.4	266.7	5.3	274.9	250.0	-9.1	125.6	132.8	5.7	146.3	125.3	-14.4
All												
Widowed to widowed	162.7	166.3	2.3	168.3	147.9	-12.1	24.9	24.7	-0.8	24.7	24.5	-0.8
Married to widowed	208.6	196.9	-5.6	220.8	163.3	-26.1	54.6	60.4	10.6	121.7	76.0	-37.6
Married to married	257.8	273.1	5.9	278.4	251.5	-9.7	147.6	157.6	6.8	164.5	144.2	-12.3
Net Financial assets												
Aged 65-74 in 2005												
Widowed to widowed	67.4	69.1	2.5	69.4	59.8	-13.8	17.6	17.9	1.7	18.0	18.1	0.6
Married to widowed	84.4	77.6	-8.0	101.3	89.7	-11.5	28.2	24.6	-12.8	32.2	28.2	-12.4
Married to married	115.8	122.6	5.9	125.0	114.1	-8.7	32.4	33.9	4.6	34.6	35.4	2.3
Aged 75+ in 2005												
Widowed to widowed	79.3	76.5	-3.6	77.3	70.4	-9.0	21.8	22.3	2.3	22.8	22.0	-3.5
Married to widowed	130.5	100.5	-23.0	118.6	72.4	-39.0	33.4	29.5	-11.7	42.4	24.5	-42.2
Married to married	120.1	126.9	5.7	130.0	125.5	-3.5	42.6	45.7	7.3	45.8	45.4	-0.9
All												
Widowed to widowed	74.6	73.6	-1.4	74.1	66.1	-10.8	20.4	20.8	2.0	21.1	20.7	-1.9
Married to widowed	109.3	89.9	-17.7	108.5	82.5	-24.0	30.0	27.1	-9.7	39.4	25.4	-35.5
Married to married	117.3	124.1	5.8	126.7	117.9	-6.9	35.7	37.4	4.8	38.3	38.9	1.6

Table 4.9: Marital status transition and changes in household portfolio composition

	Ownership rate (%)						Mean portfolio share					
	t	$t+2$	%Δ	t	$t+2$	%Δ	t	$t+2$	% Δ	t	$t+2$	% Δ
	2005	2007		2007	2009		2005	2007		2007	2009	
All												
Checking and savings accounts												
Widowed to widowed	91.1	93.6	2.7	93.3	94.5	1.4	65.1	65.9	1.2	65.5	67.2	2.7
Married to widowed	95.6	98.2	2.8	96.8	93.5	-3.3	63.4	61.4	-3.2	62.0	65.5	5.7
Married to married	97.6	97.4	-0.1	97.9	98.2	0.3	52.2	51.7	-1.0	51.1	53.7	5.2
Risky assets												
Widowed to widowed	19.2	16.8	-12.4	16.4	15.6	-4.6	5.9	5.2	-12.5	4.9	4.2	-14.4
Married to widowed	17.7	11.5	-35.0	19.4	16.9	-12.5	3.7	2.8	-25.0	2.9	2.3	-21.5
Married to married	28.7	24.7	-13.9	25.3	22.8	-9.8	6.3	5.4	-15.6	5.5	4.6	-17.4
House												
Widowed to widowed	31.6	32.7	3.5	33.0	32.3	-2.1	26.0	26.8	2.9	27.2	26.1	-4.1
Married to widowed	37.2	38.9	4.6	42.7	36.3	-15.0	28.2	30.4	8.1	32.5	28.7	-11.6
Married to married	50.3	52.3	4.0	53.3	51.6	-3.2	38.5	40.2	4.3	40.6	38.7	-4.8
Mortgage debt												
Widowed to widowed	14.1	13.0	-7.9	13.0	12.3	-5.4	2.5	2.3	-10.9	2.3	2.5	10.8
Married to widowed	17.7	16.8	-5.0	20.2	17.7	-12.0	2.1	2.2	3.0	3.6	4.2	16.9
Married to married	27.1	25.4	-6.3	26.1	24.0	-8.0	5.7	5.6	-2.2	5.7	5.4	-5.7

Notes: 'Mean portfolio share (%)' reports the average portfolio share of each asset (debt) item in 'total assets'. Total assets is the sum of checking and savings accounts, risky assets, the value of the primary residence (house) and other assets.

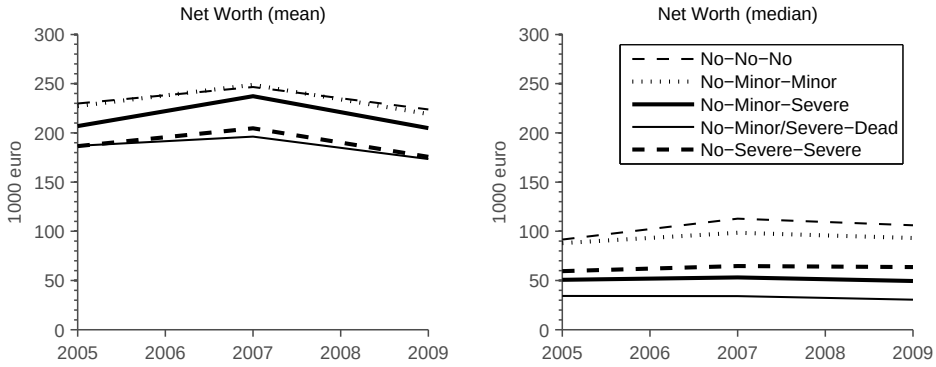
Table 4.10: Household wealth in 2005 by age, marital status and health status

	Married					Widowed				
	65-69	70-74	75-79	80-84	85+	65-69	70-74	75-79	80-84	85+
	Mean balance									
Net worth										
No health problems	265.6	251.7	237.5	303.4	332.4	224.4	166.9	152.7	179.3	146.2
Minor diseases	262.6	272.7	255.6	222.8	192.9	133	130.9	119.2	164.5	143.5
Major diseases	276.2	190.4	210.4	231.6	225.8	98.4	118.2	152.2	141.4	233.4
Net financial assets										
No health problems	110.2	116.8	100.2	168.3	205.2	89.3	61.5	67.8	100.4	89.5
Minor diseases	113.1	127.6	118.8	118	113.2	55.5	42	57.7	88.7	94.5
Major diseases	141	71.2	102.7	107.3	145.4	45.3	37	91.9	83.9	155.3
Housing equity										
No health problems	155.4	134.9	137.3	135	127.2	135.2	105.4	84.8	79	56.6
Minor diseases	149.5	145.2	136.8	104.8	79.6	77.5	88.9	61.6	75.8	49
Major diseases	135.2	119.1	107.7	124.3	80.5	53.1	81.2	60.3	57.5	78.1
	Median balance/ homeownership %									
Net worth										
No health problems	175.9	146.3	143.2	101.7	122.8	133	24.9	25	24.3	24.9
Minor diseases	158.1	161.6	112.2	69.4	64.6	13.7	24.9	21.8	24.9	23
Major diseases	110	71.2	54.1	89.4	46	14.5	20.7	22.1	17.2	22.4
Net financial assets										
No health problems	31.3	34.3	38.2	41.4	46	22.5	17.2	22.5	21.2	24.6
Minor diseases	29.4	34.9	38.8	43.7	46	7.1	17.2	17.2	24	21.5
Major diseases	28.6	28.9	33.4	39.7	46	9.8	11.9	18.3	12.2	17.3
Homeownership										
No health problems	60.2	48.7	46.0	39.7	37.0	48.26	36.47	30.12	25.51	17.18
Minor diseases	54.0	51.6	44.0	36.5	30.3	27.78	34.27	23.65	25.45	18.27
Major diseases	49.3	44.6	38.2	40.3	24.6	18.42	31.40	22.52	20.18	22.08

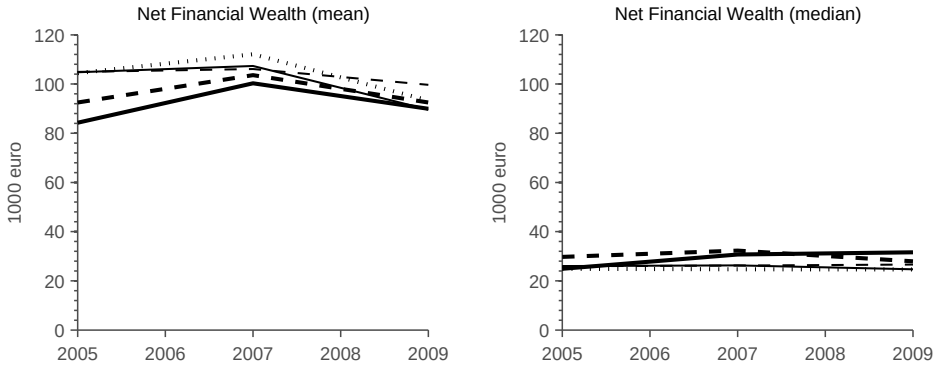
Notes: All amounts are expressed in thousands of euros and in 2010 prices using the CPI deflator. We distinguish between three categories of diseases: major diseases (cancer or cardiovascular diseases), minor diseases (all other diseases) and the remaining "healthy" group with no hospitalization. For married couples we define the household to have a 'minor disease' if neither the key person nor the partner has a 'major disease' but at least of them is admitted to the hospital during the last three waves.

Figure 4.6: Health shock and wealth holdings

(a) Net worth: mean and median



(b) Net financial wealth: mean and median



(c) Primary residence: ownership rate and fraction

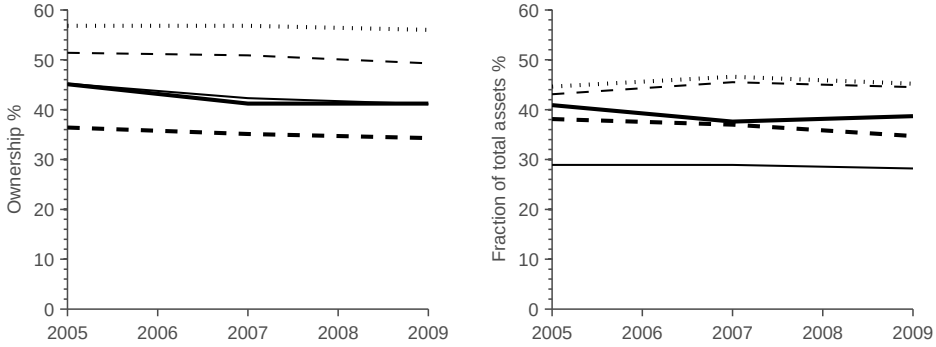


Table 4.11: Incidence of at least one day of LTC between 2004 and 2011 for the key-person of the household

	Age group in 2004							
	65-69	70-74	75-79	80-84	85-89	90-94	95+	Total
Nursing home care	12.7	19.0	32.7	49.2	67.3	74.2	83.3	34.5
Home care (personal & nursing)	26.8	38.8	54.4	63.8	60.2	48.2	29.6	47.6
Total (No.)	1,816	2,974	2,570	2,088	1,010	461	108	10,817

Notes: Information about long-term care utilization is provided by the CAK 2004-2011.

Table 4.12: Total resources of single elderly in the year before they permanently enter a nursing home (2005-2009) (%)

	Net income (in €1000s)			
Net worth (in €1000s)	<15	15-25	25+	Total (No.)
< 25	72.3	61.0	13.6	501
Net worth 26-50	6.6	10.1	9.5	79
Net worth 51-100	5.8	6.7	7.5	58
Net worth 101-200	7.3	5.4	10.9	61
Net worth 201-300	4.4	7.3	14.3	67
Net worth 300+	3.6	9.5	44.2	119
Total (No.)	274	464	147	885

Table 4.13: Years of nursing home stay covered by private resources (%)

	< 1 year	1 to 2	2 to 3	3 to 4	4 to 5	> 5 year	Total
Renters	61.7	7.1	3.7	1.0	1.2	4.4	79.2
Homeowners	0.8	0.0	0.6	0.8	1.9	16.7	20.8
Total	62.5	7.1	4.3	1.8	3.2	21.1	100.0

The table shows the maximum number of years of nursing home use that single elderly would be able to finance from private resources. The resources are measured in the year before entering a nursing home and include both income and net worth.

Table 4.14: Net Worth before death (1000 euro), Single households, Age 70 and older in 2005

	Survives			Dies		
	2005	Δ annual	Δ final year	2005	Δ annual	Δ final year
No health problems						
Mean	187.5	-2.85	-6.1	185.5	-1.62	-5.89
Median	24.85	-0.02	-0.2	24.85	0.02	-0.08
Obs	997			437		
Minor health problems						
Mean	158.3	-2.13	-3.17	140.9	1.3	-5.08
Median	24.85	-0.02	-0.2	22.7	0	0
Obs	587			364		
Major health problems						
Mean	159.7	-4.27	-4.68	149.1	-3.58	-4.7
Median	24.85	0	-0.2	20.9	0.04	0.01
Obs	526			415		

Notes: All amounts are expressed in thousands of euros and in 2010 prices using the CPI deflator. We distinguish between three categories of diseases: major diseases (cancer or cardiovascular diseases), minor diseases (all other diseases) and the remaining "healthy" group with no hospitalization. For married couples we define the household to have a 'minor disease' if neither the key person nor the partner has a 'major disease' but at least of them is admitted to the hospital during the last three waves.

Chapter 5

Health status over the life cycle

5.1 Introduction

Health is a very important asset: if you are healthy you are able to work or produce goods at home; health also plays an important role in financial planning and in consumption and saving decisions. Most people probably have a good sense what the word 'health' means; it is, however, difficult to capture health in a single measure. To measure 'true' health we preferably like to combine different sources of information, or dimensions of health, which could explain a person's latent health status. Many studies in this field use self-reported health status (SRH) as a summary measure of health. The SRH variable is typically based on a question in which people are asked to rate their own health on a five-point ordinal scale ranging from 'excellent health' to 'poor health'.

The SRH measure has proven to be a very useful measure of health but is sometimes criticized because it involves some biases. For example Crossley and Kennedy (2002) show that many persons tend to change their self-reported health status within the same survey. Inconsistent reporting over time makes it difficult to analyze the evolution of health of a person over time as it reduces the persistence in health. Psychological factors, such as a person's mood might also influence the reported health status between waves. In addition to reporting bias, two persons with the same underlying health problems might report a different SRH, due to a difference in health perception; e.g. Lindeboom and van Doorslaer (2004). Differences in health perception among age groups result in a biased life cycle health profile. In addition to measurement error and heterogeneity in health perception, SRH seems also sensitive to justification bias as was first mentioned by Bound et al. (1999); people outside of the labor market tend to justify their labor

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market status by reporting worse health in a survey.

Another disadvantage, at least from our perspective, is that SRH is only available for a relatively small sample of the population. As administrative data from medical registers become more widely available, there is a growing interest to use these data. Important benefits of large administrative data are the possibility to focus on very specific groups in the population and the absence of survey attrition—which is often related to a deterioration in health (Jones et al., 2006).

In this chapter, we estimate a health measurement model where we link survey data on SRH to a rich set of objective health conditions from medical records. Relying on objective health measures, instead of self-reported health conditions in survey data, has several advantages. Objective health conditions do not suffer from justification bias and are less prone to reporting bias (Baker et al., 2004). Even though the questions to measure health outcomes in the Health and Retirement Study (HRS) and other similar surveys such as SHARE, PSID and ELSA are very specific there is ample evidence that self-reported health outcomes in survey data are sensitive to reporting bias. Johnston et al. (2009) show that the large majority of individuals in the UK who are diagnosed with hypertension, which is a very common disease, do not report this in a health questionnaire, though the question is very clear.[1] Also measures like ADL, which are often used as 'objective' measures in health measurement models, may be prone to reporting bias. Shulman et al. (2006), for example, find discrepancies between patients subjective reporting of ADL and IADL and their objective ratings.

On the other hand, SRH might contain information on 'true' health not being captured by the objective health conditions. It is important to take these unobserved individual differences in health into account, otherwise the persistence in health status might be underestimated. We account for unobserved individual differences in health as well as the persistence in unobserved health shocks by exploiting the panel dimension of our data. One problem is that inconsistent reporting over time in SRH (i.e. measurement error) will reduce the estimated persistence in unobserved health. The Longitudinal Internet Study in the Social Sciences (LISS) panel, administered by CentERdata in the Netherlands, allows us to examine the existence of possible inconsistent reporting patterns. In addition to the standard SRH question, respondents are asked to report the change in their health compared to last year. For some respondents we notice inconsistent reporting over time by comparing the SRH measure and the self-reported change in health (SRCH) measure. For instance, some respondents state that their health did not deteriorate over the last year while they report being in worse health compared to last year, or vice versa. These inconsistencies cannot be explained

[1] The wording of such a question in a survey is typically as follows: "Has a doctor ever told you that you have high blood pressure or hypertension?"

by phenomena such as learning about health status over time, a change in social perception about certain health conditions, or medical innovations, since this would probably result in an up- or downward trend in SRH. We use both measures of SRH to construct a 'corrected' measure of SRH which accounts for these inconsistencies. We show that this corrected measure substantially increases the estimated persistence in health.

Several methods have been put forward to construct a health index using survey data on SRH and on a vector of variables $\boldsymbol{x}$, which measure objective health conditions. A useful overview of the different approaches proposed in the literature is provided by Kapteyn and Meijer (2013), Lindeboom and van Doorslaer (2004) and Cutler et al. (1997). Our method is closely related to the method proposed by Jürges (2007) (who uses a similar approach that were used in Bound (1991)) which boils down to estimating an extended ordered probit model with SRH as dependent variable and objective health measures as explanatory variables. We will extend the approach of Jürges in three directions. First, we exploit the fact that we have panel data on SRH at our disposal. This allows us to take into account unobserved heterogeneity and the persistence in unobserved health shocks. Second, we are able to enrich the LISS survey data with a large set of health indicators stemming from administrative sources. This set of health indicators is very similar to the variables used in the latent health index developed by Poterba et al. (2010) who use measures collected in the HRS. Their latent health index is widely used in recent research, and well able to explain saving and retirement behavior as shown by Kapteyn and Meijer (2013). Related studies to our work by Lange and McKee (2012) and Heiss et al. (2014) also emphasize the importance of using multiple 'objective' measures of health to construct a single index and to account for unobserved heterogeneity in health. Third, we account for inconsistent reporting in SRH over time which, not taking into account, reduces the estimated persistence in health. A good understanding of the persistence in health status is crucial for explaining saving behavior and designing health and long-term care insurance, among other things; see e.g. De Nardi et al. (2010).

The estimated health model allows us to predict health status for the population at large. We account for the stochastic properties of unobserved differences in health. The advantage of using administrative data is that we can focus on specific subgroups that are usually small in surveys–such as the oldest-old—and that we overcome health related attrition in survey data. We use the predicted objective health status for the large administrative data to study the evolution of health as individuals age. This allows us to answer important questions such as: What is the likelihood of a deterioration in health at different stages in life and how persistent is this health shock? Does the evolution of health differ by socio-economic status and by gender? Do education and economic variables reduce the risk to get in poor health and how does this differ by

gender?

Many studies, such as Case and Deaton (2005) for the US show, that women report a lower SRH than men and that the health status of men deteriorates at a faster rate than women. A recent study by Ross et al. (2012) for the US reports that the relationship between education and health is stronger for women than for men. One explanation for this gender gap is a difference in health perception rather than a difference in the prevalence of chronic disease between men and women. Another explanation could be that women are more inclined to mention health problems then men in a survey. Our health measurement model deals with both measurement problems. Contoyannis et al. (2004) analyze the dynamics of health status among British men using SRH, they do not find clear differences in the health persistence by education and income.

Our main results are as follows: First, using both the corrected and uncorrected measure of SRH shows significant differences in the estimated persistence in health. For both measures of SRH, objective medical conditions, such as having diabetes, affect SRH in a similar way; using the corrected SRH measure, however, substantially increases the persistence in health. Second, we find that people of low socio-economic status are more likely to stay in poor health —independent from the measure we use. The age at which health starts to decline at a greater rate arrives earlier for males and persons with a lower level of education. Finally, we show that women on average are in worse health than men due to a higher prevalence of chronic diseases which have a relative detrimental effect on health. Woman's health seems to benefit more from having higher education than men. We also provide evidence that income and wealth are protective of health over and above education.

The outline of the chapter is as follows. Section 5.2 explains the health measurement model. Section 5.3 extensively discusses the survey data set and administrative data. Section 5.4 discusses the estimation results of the health measurement model and the ability to explain the empirical patterns in for example SRH. Section 5.5 presents descriptive statistics on the persistence in health and the evolution of health over the life cycle. The final section concludes.

5.2 A longitudinal health measurement model

5.2.1 Different approaches to model health

Several methods have been put forward to construct a health index using survey data on SRH and on a vector of variables $\boldsymbol{x}$, which measure health conditions or difficulties with activities of daily living.

Our method is closely related to the method proposed by Jürges (2007) who estimates

an extended ordered probit model with SRH as dependent variable and objective health measures $\boldsymbol{x}$ as explanatory variables. The extended ordered probit model assumes the existence of a single latent health index y^* which is equal to $\boldsymbol{x}'\boldsymbol{\beta}$. The value of the health index is predicted as follows: $\hat{y}^* = \boldsymbol{x}'\hat{\boldsymbol{\beta}}$. Notice that self-reported health is only used in the construction of the index but not in the prediction of the index. Poterba et al. (2010) use a somewhat different approach: in their model latent health status not only directly influences self-reported health but also all other health measurements. This results in a factor analysis model from which they derive the first principal component as their health index. In the empirical analysis Jürges uses the first wave of the SHARE survey, which includes information of 22,000 individuals aged 50 and above from ten European countries. Like many others the author stresses that the SRH measure is not comparable across countries because of differences in reporting style. For this reason he does not use the standard ordered probit model in his analysis but an extended version of it which allows the threshold parameters to be different across countries, which is known as a 'cut-point shift'. Lindeboom and van Doorslaer (2004) point out that heterogeneity in reporting behavior could not only lead to a cut-point shift but also to a so-called 'index shift' in the β parameters of the latent health index. They propose some likelihood ratio tests to check whether cut-point shifting and index shifting are relevant phenomena. Jürges deliberately does not allow for a country specific $\boldsymbol{\beta}$ vector so that he does not need to choose a 'reference country' in the cross-country comparison of general health.[2]

Lindeboom and van Doorslaer (2004) show that reporting not only varies across countries. They present evidence for both 'cut-point shifts' and 'index shifts' across age groups and gender: females and older persons are more likely to understate their health status compared to males and younger individuals.[3] A possible explanation is that persons compare their health status relative to another person of the same age and gender—in some surveys respondents are actually asked to report their health status relative to another person of the same age. This implies that there is a flattened out age profile in SRH. Since we are interested in modelling 'true' health status over the life cycle it is important to take this difference in reporting style into consideration. Lindeboom and van Doorslaer (2004) find no clear evidence that reporting differs by socio-economic status; which is also shown by McFadden et al. (2009).

[2]To be more precise, Jürges divides the estimated coefficients $\hat{\boldsymbol{\beta}}$ by the difference between the highest and lowest predicted health level to come up with a predicted health index which takes a value between zero and one. These scaled coefficients are referred to as 'implicit disability weights'. Poterba et al. (2010) ranks the predicted health status in percentile scores.

[3]The authors use cross-sectional data from Canada. It is well-known that in a cross-section study we cannot distinguish age effects from cohort effects. In other words the age effect could also be interpreted as a generation effect. In our study we use panel data to allow the threshold parameters to be cohort specific and not age specific.

5.2.2 Constructing a health index

In this section we introduce our longitudinal ordered response model in more formal terms. This model should enable us to predict a single latent true health index for individual i in period t by means of a set of health indicators $\boldsymbol{x}_{it}$ from administrative sources. The ordered response model assumes a linear relationship between a latent health index y^*_{it} and $\boldsymbol{x}_{it}$:

$$y^*_{it} = \boldsymbol{x}'_{it}\boldsymbol{\beta} + \varepsilon_{it},\ t = 1, \ldots, T, \tag{5.1}$$

where ε_{it} represent unobserved factors influencing SRH which are not captured by the explanatory variables, such as lifestyle. We assume that this error term is standard normal distributed conditional upon $\boldsymbol{x}_{it}$: $\varepsilon_{it}|\boldsymbol{x}_{it} \sim N(0,1)$. Notice that the $\boldsymbol{\beta}$ parameter vector may vary across demographic groups. However, we do not allow for index shifting to keep the model parsimonious.

Since we are interested in the evolution of health over the life cycle, it is important to model the persistence in the random effect ε_{it}. Persistence in health can be the result of (1) persistence in observed medical conditions, (2) serial correlation in the error term—for example the experience of recurring health problems after the diagnosis of a chronic diseases such as diabetes—or (3) because of unobserved heterogeneity, for example if unhealthy lifestyle increases the probability of experiencing health problems and this is not captured by the observed variables. In light of these considerations, we assume that the error term ε_{it} can be decomposed into a random individual effect c_i and an idiosyncratic error term u_{it} which represent unobserved health shocks:

$$\begin{aligned} \varepsilon_{it} &= c_i + u_{it} \\ c_i &\sim NID(0, \sigma_c^2) \\ u_{it} &\sim N(0, \sigma_u^2) \\ \operatorname{cov}(c_i, u_{it}) &= 0,\ t = 1, \ldots, T. \end{aligned}$$

Given these assumptions, $\sigma_u^2 = 1 - \sigma_c^2$ because $\operatorname{var}(\varepsilon_{it}) = 1$. As we said above, the unobserved health shocks u_{it} are likely to be rather persistent. We therefore model u_{it} by means of an AR(1) process:

$$\begin{aligned} u_{it} &= \gamma u_{it-1} + \zeta_{it} \\ \zeta_{it} &\sim NID(0, \sigma_\zeta^2). \end{aligned}$$

Since $\operatorname{var}(\varepsilon_{it}) = 1$, it holds that $\sigma_\zeta^2 = \sigma_u^2 \cdot (1 - \gamma^2) = (1 - \sigma_c^2) \cdot (1 - \gamma^2)$.

As we said before SRH is measured on a 5-point scale. We assume the following relationship between SRH_{it} and the latent health index y^*_{it}:

$$SRH_{it} = L \text{ if } \lambda^g_{L-1} < y^*_{it} \leqslant \lambda^g_L,\ L = 1, \cdots, 5;\ g = 1, \ldots, G, \tag{5.2}$$

where $\boldsymbol{\lambda}^g = (\lambda^g_1, \lambda^g_2, \lambda^g_3, \lambda^g_4)'$ are the threshold parameters for demographic group g ($\lambda^g_0 = -\infty$ and $\lambda^g_5 = \infty$). We allow the thresholds to differ by demographic group g to account for reporting heterogeneity in health ('cut-point' shifting). Based on earlier empirical work by Lindeboom and van Doorslaer, 2004 we distinguish on the basis of the variables 'gender' and 'year-of-birth cohort'.[4]

We further assume that the thresholds as well as the β parameters are constant over time. The β parameters may change over time if medical innovations reduces the impact of certain medical conditions on SRH. In the empirical analysis we will formally test this assumption. We also test for 'index-shifting', the AR(1) structure of the error term and whether the autocorrelation of the error term and the random effect differs between gender and year of birth cohort.

5.2.3 Estimation of the health index model

In this subsection we explain how we estimate the 'structural' parameter vector $\boldsymbol{\theta} = (\boldsymbol{\beta}', \sigma^2_c, \gamma)'$. For the explanation of the estimation procedure it is relevant to know that our survey data consists of four waves (see the data description in the next section). Estimation is done in several steps. First, we estimate for each demographic group g the multivariate ordered probit model where the dependent variables are SRH in waves 1 till 4.[5] Obviously, the vectors of threshold parameters $\boldsymbol{\lambda}^g_t,\ t = 1, \ldots, 4$ are also wave specific. The multivariate ordered probit model assumes the following relationships between the latent health indices and the explanatory variables:

$$\begin{aligned}
y^*_{i1} &= \boldsymbol{x}'_{i1}\boldsymbol{\beta}^g_1 + \varepsilon_{i1} \\
y^*_{i2} &= \boldsymbol{x}'_{i2}\boldsymbol{\beta}^g_2 + \varepsilon_{i2} \\
y^*_{i3} &= \boldsymbol{x}'_{i3}\boldsymbol{\beta}^g_3 + \varepsilon_{i3} \\
y^*_{i4} &= \boldsymbol{x}'_{i4}\boldsymbol{\beta}^g_4 + \varepsilon_{i4},
\end{aligned}$$

[4] We create five different demographic groups ($G = 5$): males born before 1945, females born before 1945, males born between 1945 and 1965, females born between 1945 and 1965 and individuals born after 1965.

[5] We use the Stata module CMP developed by Roodman (2011) for the estimation of the multivariate ordered probit model.

where the vector $\boldsymbol{\varepsilon}_i = (\varepsilon_{i1}, \varepsilon_{i2}, \varepsilon_{i3}, \varepsilon_{i4})'$ is normally distributed conditional upon $\boldsymbol{x}_i = (\boldsymbol{x}_{i1}, \boldsymbol{x}_{i2}, \boldsymbol{x}_{i3}, \boldsymbol{x}_{i4})'$:

$$\boldsymbol{\varepsilon}_i | \boldsymbol{x}_i \sim NID \left(\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho^g_{21} & \rho^g_{31} & \rho^g_{41} \\ \rho^g_{21} & 1 & \rho^g_{32} & \rho^g_{42} \\ \rho^g_{31} & \rho^g_{32} & 1 & \rho^g_{43} \\ \rho^g_{31} & \rho^g_{32} & \rho^g_{43} & 1 \end{pmatrix} \right).$$

The first step of the estimation procedure yields for each demographic group g an estimate of the following vector of 'auxiliary' parameters $\boldsymbol{\xi}^g = (\boldsymbol{\eta}_1^{g'}, \ldots, \boldsymbol{\eta}_4^{g'}, \boldsymbol{\rho}^{g'})'$ where $\boldsymbol{\eta}_t^g = (\boldsymbol{\beta}_t^{g'}, \boldsymbol{\lambda}_t^{g'})'$, $t = 1, \ldots, 4$ and $\boldsymbol{\rho}^g = (\rho^g_{21}, \rho^g_{31}, \rho^g_{41}, \rho^g_{32}, \rho^g_{42}, \rho^g_{43})'$. In the second step we apply a minimum distance estimation procedure in which we impose the restriction that the parameters of the index functions and the threshold parameters are not wave specific, i.e. $\boldsymbol{\eta}_1^g = \ldots = \boldsymbol{\eta}_4^g = \boldsymbol{\eta}^g = (\boldsymbol{\beta}^{g'}, \boldsymbol{\lambda}^{g'})'$.[6] This second step yields consistent estimates of the vector: $\boldsymbol{\theta}^{*g} = (\boldsymbol{\beta}^{g'}, \boldsymbol{\lambda}^{g'}, \boldsymbol{\rho}^{g'})'$. In the third step we follow Jürges (2007) and apply a minimum distance step in which we impose the restriction that there is no 'index shifting'. In other words, we assume that $\boldsymbol{\beta}^g = \boldsymbol{\beta}$ and $\boldsymbol{\rho}^g = \boldsymbol{\rho}$. In the fourth and final step of the estimation procedure we impose the restriction that the error term ε_{it} can be decomposed into a random individual effect c_i and an AR(1) distributed idiosyncratic term u_{it}. These restrictions imply the following relation between the 'auxiliary' parameter vector $\boldsymbol{\rho}$ and the 'deep' parameters σ_c^2 and γ:

$$\rho_{21} = \rho_{32} = \rho_{43} = (1 - \gamma)\sigma_c^2 + \gamma \tag{5.4a}$$

$$\rho_{31} = \rho_{42} = (1 - \gamma^2)\sigma_c^2 + \gamma^2 \tag{5.4b}$$

$$\rho_{41} = (1 - \gamma^3)\sigma_c^2 + \gamma^3. \tag{5.4c}$$

5.2.4 Prediction of the health index in a large administrative data set

Next, we use the estimated parameters γ, σ_c^2 and $\boldsymbol{\beta}$ to construct a health index for a large random sample of the Dutch population. The health index is a linear prediction of true health status

$$\hat{y}^*_{it} = \boldsymbol{x}'_{it}\hat{\boldsymbol{\beta}} + \tilde{c}_i + \tilde{u}_{it}. \tag{5.5}$$

where $\boldsymbol{x}'_{it}\hat{\boldsymbol{\beta}}$ is the estimated conditional expectation of true health status given observed health indicators. As mentioned before, SRH is only used in the construction of the

[6] See e.g. Cameron and Trivedi (2005) for more information about the minimum distance estimation procedure.

index but not in the prediction of the index. To correct for the stochastic properties of the error term we add a simulated composite residual $\tilde{c}_i + \tilde{u}_{it}$ to $\boldsymbol{x}'_{it}\hat{\boldsymbol{\beta}}$, similar to stochastic regression imputation to restore lost variability in the data (Little et al., 2002).

For the simulation of the composite error term we first assign each person an individual random effect $\tilde{c}_i$ by drawing it from a normal distribution with zero mean and variance $\hat{\sigma}_c^2$. Next, we impute a value of the idiosyncratic error term in the first period $\tilde{u}_{i1}$ by performing a random draw from a normal distribution with zero mean and variance $1 - \hat{\sigma}_c^2$. Finally we draw $\tilde{\zeta}_{it},\ t = 2, \cdots, T$ from a zero mean normal distribution with variance $(1-\hat{\gamma}^2)(1-\hat{\sigma}_c^2)$ to simulate $\tilde{u}_{it}$ for subsequent periods exploiting that u_{it} follows an AR(1) process.

5.3 Data

We distinguish between two samples. The first sample contains survey data on SRH from the Longitudinal Internet Study in the Social Sciences (LISS) between 2007 and 2010. We link this 'LISS sample' to administrative medical data. In addition, we use a large sample of 200,000 individuals on 1 January 2006 from the Dutch municipal population register for which we predict the health index. This sample is linked to administrative medical data and administrative data which contain socio-economic and demographic measures.

5.3.1 LISS

Survey data are taken from the LISS panel, gathered by CentERdata. This panel is recruited through address-based sampling (no self-selection). Households without a computer and/or internet connection receive an internet connection and computer for free. Residents of institutions and nursing homes are excluded from the survey. This roughly nationally representative household panel (Van der Laan, 2009) receives online questionnaires each month, on different topics. When respondents complete a questionnaire they receive a monthly incentive. A variety of data is available from studies conducted in the LISS panel.[7] In this chapter we use the yearly survey on health.

In the LISS panel we select all respondent of the yearly survey on health from 2007 to 2010. This data set consists of 24,486 individual-year observations. To link administrative data to the panel members, an opt-out consent method was used. In September 2011 all panel members received an email asking whether they objected against match-

[7]For more information, see http://www.lissdata.nl/lissdata/.

ing their survey responses with administrative resources (Das and Couper, 2014). A small minority objects against linkage. Unfortunately, not all of our respondents were still participating in September 2011. For these people we have no consent and because of ethical considerations we could not link their survey answers to the administrative data. Administrative records can be retrieved for 17,114 of the 24,486 observations (70%). Nonetheless, in 2007 SRH among those who can be linked to administrative data is not significantly different from the SRH among those who cannot be linked. This suggests that the loss of observations due to linking with administrative data does not yield an endogenous sample selection.[8] When we pool the data for all years (2007-2010), SRH is significantly different at the 5 percent level for those who can and cannot be linked to administrative records.[9] The differences, however, are not substantial as can be seen in table 5.1. Since we are interested in the working age population, we select all individuals of age 15 and older. The resulting sample consists of 16,720 observations.

To measure SRH, we use the following two questions in the LISS questionnaire.

How would you describe your health in general? With response options: Poor, Moderate, Good, Very Good and Excellent.

Can you indicate whether your health is poorer or better, compared to last year? With response options: considerably poorer, somewhat poorer, the same, somewhat better and considerably better.

The first question gives us what we call the 'uncorrected SRH'. The latter question is used to construct what we call the 'corrected SRH'. By using the second question we account for inconsistencies in individual response pattern of health status over time. For the construction of the corrected measure of SRH status we use the following steps: first, we assume that in the first period we observe a persons' 'true health status'. Next, we assess whether the health status of the same persons improves, stays the same, or degenerates in the subsequent period. We compare this change in the level of SRH with the self-reported change in health status (SRCH), which can be either "poorer", "the same", or "better". If the change in the reported level of health does not correspond with the reported change in health, we will modify this measure as follows: (1) if the level improves or degenerates and no change is reported we assume that true health status remains the same; we adjust the level of health in the subsequent period by reducing/increasing the level of SRH by one unit.[10]

[8] The p-value corresponding to the null hypothesis of no difference is equal to 0.733

[9] The p-value corresponding to the null hypothesis of no difference is equal to 0.011

[10] A more detailed description of the adjustment is available upon request.

Table 5.2 shows that the distribution of corrected and uncorrected SRH is almost the same. Most people have a good health status (60%). Transitions, however, occur less often when using corrected SRH. The diagonals in table 5.3 present the percentage of people with unchanged health status. Most of the people in good health are also in good health in the next period (79% and 88% for uncorrected and corrected SRH, respectively). With the uncorrected measure of self-reported health about 40-55% of the people in excellent of very good health end up in a worse health status in the next period. For the corrected health measure this is about 18-22%.

5.3.2 Administrative sample

From the Municipal Population Register (in Dutch: Gemeentelijke Basisregistratie) we draw a random sample of 200.000 Dutch residents for whom educational attainment is available. This register contains demographic information on age, gender, marital status, among others.

For the sample to be representative, we sample with a higher probability from the older age groups. That is because for middle aged and older individuals, educational attainment is not available in educational registers. For a large part of the older population—approximately 10 percent of the population—educational attainment is registered in the Labor Force Survey (LFS). The LFS is a representative large scale rotating panel for the noninstitutionalized population which started in 1996. Once a person participates in the LFS, educational attainment is registered. Furthermore, it is updated if a higher educational level is registered in a subsequent survey. The LFS does not sample institutionalized persons, such as individuals in nursing homes. However, educational attainment is available for this group if observed in the LFS before a person permanently moves to a nursing home. As a result, educational attainment is also available for many persons who stay in a nursing home (although these people are not included in the analysis).

We link administrative records on health (which we describe in the next paragraph) and on income, wealth and education to the Municipal Population Register on the basis of a unique personal identifier. Wealth and income data are based on the national tax register and on data from banks, which are available for the whole population.

For a small number of individuals we are unable to link the data records on income (0.77% of the sample). We have checked whether this is related to the person's age or health status (i.e. proximity to death), but this seems not to be the case. We drop these observations from our sample.

From the administrative records on income and wealth we create a variable measuring total household wealth (net worth), a variable measuring net household income, a

dummy for home ownership, variable measuring household size and dummy variables for labor market status. Educational attainment refers to the highest level of completed education, according to the Standard Classification of Education (SOI). In the analysis we distinguish between three groups: lower education (primary education or first stage secondary education), intermediate education (second stage secondary education) and higher education (University Bachelor or University Master or higher).

Again, we select all individuals age 15 and older since we are interested in the working age population. In addition we exclude persons from the year of entering a nursing home to make the sample comparable with the LISS survey. Table 5.4 shows the sample statistics.

5.3.3 Administrative medical data

In the analysis we use dichotomous indicators of having a medical condition in a specific year. We derive these medical conditions from two sources: (1) the use of prescription medication, and (2) the main diagnosis responsible for hospitalization. The data about prescription medication is administered by the National Health Care Institute (in Dutch: Zorginstituut Nederland). In the data set the dispensed drugs is classified by the Anatomical therapeutic chemical (ATC) code. With this code we identify the presence of specific medical conditions. We use the same mapping between a specific substance and medical condition as Lamers and van Vliet (2004) and Chini et al. (2011). For example, the ATC-code for insulin is 'A10A' which is used medically to treat (some forms) of diabetes.[11] The derived conditions are mainly chronical.

The main diagnosis responsible for hospitalization is based on the Tenth edition of the International Classification of Diseases, ICD10, derived from the hospital discharge register (in Dutch: Landelijke Medische Registratie, LMR). The LMR contains data about hospital admission (inpatient stays) and covers all general and university hospitals and most specialized hospitals.[12] We use the data from 2007-2010 and identify the same group of medical conditions as the group of conditions derived from prescription medication.[13] In addition to the indicators of having a medical condition we create three indicator variables of medical utilization: (1) hospital admission (2) prescription drug use, and (3) receiving care at home. The data set on the use of long-term care is provided by CAK (in Dutch: Centraal Administratie Kantoor).

Table 5.5 provides an overview of the prevalence of medical utilization and the prevalence of medical conditions in both the LISS survey and the administrative sample. We

[11] Table 5.12 in the appendix describes the exact mapping of diseases to chronical conditions.

[12] The LMR covers approximately 88% of all inpatient hospital stays (Van der Laan, 2013).

[13] The analysis is primarily based on the prescription medication data. We use the hospital data as a sensitivity check. In that case we classify a person as having a disease if a condition is observed in either one of both sources.

distinguish between men and women in the LISS sample and the administrative sample. The prevalence of medical utilization and medical conditions is about the same in the two samples, as we would expect given that the LISS panel is a representative sample of the Dutch population. The LISS survey asks respondents, in addition to SRH, whether they are currently taking medicine at least once a week for a specified condition and whether the physician has told them that they suffer from a specific disease last year. We use this information to create an indicator variable of having a 'self-reported' medical conditions.

Column three of table 5.5 reports the self-reported prevalence of medical condition based on both questions. Comparing the self-reports to administrative records suggests that respondents tend to underreport medical conditions such as mental problems while for cardiac diseases and diabetes the prevalence is about the same. Bharadwaj et al. (2015) report similar discrepancies in the US which they contribute to stigma about mental illness.

5.4 Results

5.4.1 Health index

Table 5.6 shows the estimation results of the health index model. As we explained in section 5.2 these estimates are obtained by first estimating for each demographic group a multivariate ordered probit model in order to obtain estimates for some auxiliary parameters and then perform sequentially some minimum distance estimation (MDE) steps. In the first MDE step we impose for each demographic group the restriction that the β and threshold parameters are constant over time. The results of the goodness of fit tests indicate that it is allowed to impose these restrictions.

The second MDE step hinges on the hypothesis that all parameters of the health index model except the threshold parameters do not vary across the demographic groups which we consider in this study. The goodness-of-fit test statistic indicates that this hypothesis should be rejected at any reasonable significance level. Nonetheless, we choose to impose these restrictions because we can then construct a 'unique' health index which does not depend on a chosen reference group. In the last MDE step we estimate the parameters γ and σ_c^2 from the autocorrelation coefficients (cf. the system of equations 5.4). The goodness of fit test indicates that the stochastic part of the health index model can be effectively modeled by means of a random individual effect and an AR(1) distributed idiosyncratic error term.

We first consider the model using only information on chronic diseases and do not consider inpatient treatment for the same chronical condition. In the first column of

table 5.6 the 'uncorrected' SRH measure is the dependent variable. The estimated coefficients, of the impact of a disease on SRH, are displayed in order. All coefficients have the expected negative sign and are highly significant except for tuberculosis, which has the wrong sign but is insignificant, and glaucoma, which is insignificant but has the correct sign. It is informative to compare our results with other studies to interpret the magnitude of the effect of specific chronic illnesses on subjective health. In line with earlier clinical studies (see e.g. Sprangers et al., 2000 and Gilliam, 2003) we find that neurologic conditions, such as epilepsy and Parkinson's disease, have a sizeable negative association with perceived health. For diabetes, we find a relative large negative effect in comparison with other studies, and for rheumatic conditions a relative small association. For the other conditions we find a similar ranking of the coefficients.

The lower part of table 5.6 reports the estimated threshold parameters. The estimates of the threshold parameters suggest that reporting behavior differs significantly across the five demographic groups which we distinguish in this study (cut-point shifts). If we only compare males and females born before 1945 with the same health index y_{it}^* it turns out that males are more positive about their health status than females: for instance, elderly females are more likely to report 'moderate' or 'poor' health than elderly males. There does not seem to exist large gender-specific differences in the reporting behavior of the 'middle' generation (born between 1945 and 1965). The youngest generation (born after 1965) has a higher tendency to report that their health is 'very good' or 'excellent' than other generations. It should be stressed again that all the findings on reporting behavior hinges on the assumption that the β-parameters of the health index (cf. equation 5.1) do not differ across demographic groups.

The estimates of the parameters σ_c^2 and γ imply that correlation between y_{it}^* and y_{it-1}^* is equal to $(1-\gamma)\cdot\sigma_c^2+\gamma = 0.70$. This first autocorrelation coefficient is not that large: if we use these estimates to impute values of the health index in the administrative data set (cf. equation 5.5) we find that health evolves over the life cycle in a rather erratic way (i.e. big upward and downward shocks in the value of the health index). That is the reason that we also constructed a 'corrected health' measure to account for reporting error. Column two of table 5.6 reports the estimates of health index model with the corrected health measure as the dependent variable. It turns out that in this case the estimates of σ_c^2 and γ are completely different: $\hat{\sigma}_c^2 = 0.161$ and $\hat{\gamma} = 0.856$. We obtain a larger estimate for the first order autocorrelation coefficient of the health index y_{it}^*: 0.88 versus 0.70. For both measures of SRH, objective medical conditions, such as having diabetes, affect SRH in a similar way. Overall, the estimates of the β and threshold coefficients become slightly smaller in absolute value if we take the corrected SRH measure as dependent variable in the health index model instead of the uncorrected one.

In the previous estimations we did not account for inpatient treatment for the sam e chronical condition, which might influence the results. Inpatient treatment can either be interpreted as a health shock (first occurrence of the disease) or a treatment to cure someone's health. Column 3 shows the results when we combine the medical information on chronical conditions based on prescription drug use and hospitalization. We classify a person as having a disease if a medical condition is observed in either the hospital data or prescription drug data. We have excluded the insignificant disease groups glaucoma and tuberculosis and include the disease groups: Alzheimer, dementia and psychosis; osteoporosis and Paget disease; and migraine to the specification. The results are very similar to the results which only use the prescription drug data. For the added variables we find that both having Alzheimer, dementia or psychosis and having osteoporosis and Paget disease has a large negative influence on health.

Next, we analyze whether the results change if we estimate the index 'solely' on the basis of self-reported medical conditions as reported in the LISS survey. We therefore substitute the disease groups as observed in the administrative data (column 3 of table 5.6) by self-reported medical conditions in the LISS survey. The variables of which no self-reported information is available are indicated in the table.[14] Column 4 of the table shows that there are noteworthy differences. For most diseases we find significantly lower coefficients. The coefficients of diabetes and cardiac diseases for which there seems little underreporting in the LISS data remain very similar in magnitude. This suggests that we should take measurement error issues seriously.

To examine the fit of the health measurement model we use the estimated coefficients to predict the transition probabilities for the LISS sample. We calculate these in-sample predictions as follows:

$$\begin{aligned}
&\Pr\left(SRH_{it} = l | SRH_{it-1} = k, x_{it}, x_{it-1}\right) = \\
&\Pr\left(\hat{\lambda}^g_{l-1} - x'_{it}\hat{\beta} < \varepsilon_{it} < \hat{\lambda}^g_{l} - x'_{it}\hat{\beta} | \hat{\lambda}^g_{k-1} - x'_{it-1}\hat{\beta} < \varepsilon_{it-1} < \hat{\lambda}^g_{k} - x'_{it-1}\hat{\beta}\right) = \\
&\frac{P(\hat{\lambda}^g_{l-1} - x'_{it}\hat{\beta} < \varepsilon_{it} < \hat{\lambda}^g_{l} - x'_{it}\hat{\beta}, \hat{\lambda}^g_{k-1} - x'_{it-1}\hat{\beta} < \varepsilon_{it-1} < \hat{\lambda}^g_{k} - x'_{it-1}\hat{\beta}, \hat{\rho}_{12})}{P(\hat{\lambda}^g_{k-1} - x'_{it-1}\hat{\beta} < \varepsilon_{it-1} < \hat{\lambda}^g_{k} - x'_{it-1}\hat{\beta})}, \\
&\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad k, l = 1, \ldots, 5
\end{aligned}$$

where the first-order autocorrelation coefficient equals $\hat{\rho}_{12} = (1 - \hat{\gamma})\,\hat{\sigma}^2_c + \hat{\gamma}$. Table 5.7 shows the in-sample predictions. A comparison of table 5.3 and table 5.7 shows that for both the uncorrected and uncorrected health measures the predicted and empirical transition probabilities agree reasonably well although the health measurement model

[14] For the following variables no self-reported information is available: Parkinson's disease, Alzheimer, dementia and psychosis; Epilepsy; Thyroid disorders; Chronic pain and Migraine.

assigns somewhat higher probabilities to the off-diagonal elements of the transition matrix.

5.4.2 Persistence in health

Table 5.8 shows transition probabilities for predicted health in the administrative sample by educational attainment. We construct predicted health status on the basis of the estimated thresholds. We use the thresholds of middle-aged males as a reference group for all individuals in the sample.

The table shows that lower educated people are much more likely to stay in poor health than higher educated people (university bachelor or master). This does (by construction) not depend on using either the uncorrected measure or corrected measure. Table 5.9 shows the transition matrix by income quintile (only for the uncorrected measure). We observe a higher persistence of staying in poor health for low income households than for their high income counterparts. We do not observe important differences in health persistence if we stratify the sample by wealth quintile (Table 5.9).[15]

5.4.3 Evolution of health status over the life-cycle

To describe the evolution of health over the life cycle we estimate fixed effects models on the administrative sample. The fixed effect captures unobserved time-invariant individual effects, such as cohort effects. The model contains a dummy for every age and is estimated separately by gender and educational level. We present the results for the linear prediction of health since the (un)corrected measure generates a somewhat erratic pattern for the highest age groups. As we estimate a fixed effect model we can only interpret the slope, or the evolution, in health status as people age, and not the difference in the (initial) level of health. For an easier comparison we let all figures start at zero.

Figure 5.1 reports the estimated age pattern for both males and females. Health deteriorates with age; as from age 50 we observe that health starts to decline at a faster rate for both males and females. For both males and females we observe that health declines at a similar pace up to about age 60. For men, we observe a further increase in the rate of deterioration in health as from age 60. As a results, there is about a 0.3 standard deviation difference in health between men and women at age 95, which corresponds to having cardiac disease.

Figure 5.2 reports the health pattern for different levels of education for males. We observe strong differences in the age gradient by level of education. For lower educated males we observe a relative high gradient already from age 25 onwards; as from age 50

[15] We notice that the level of income and wealth also differs by age-group.

the level of health starts to decline at an even faster rate. For males with an intermediate level of education, the level of health declines slowly up to age 55, after that age the deterioration in health steadily start to accelerate. For highly educated males we also observe a relatively flat age gradient, after age 55 health starts to decline more rapidly. The gradient is however flatter than for males with an intermediate level of education.

Figure 5.3 stratifies the health profile for females by education. There are three important differences compared to the health profiles for males: First, for lower educated women, the gradient is less steep than for men. Second, for higher and intermediate levels of education the gradient is very similar to men, but the gradient stays relatively linear up to age 70; thereafter health starts to decline at a somewhat faster rate (but not as fast as for men). Finally, also for lower educated women, the increase in the deterioration of health starts at a later age and the gradient is less steep than for men.

These figures show two broad patterns. First, there is a strong gradient in education. Second, we observe a gender and education difference in the timing when the rate of worsening in health speeds-up. This moment arrives earlier for males and persons with a lower level of education.

Do education and economic resources reduce the risk to get in poor health and how does this differ by gender? Table 5.11 gives results from a regression of health estimated separately for men and women. The different models include dummies for the level of educational attainment (the reference category is lower education), income and wealth quantiles (the bottom quantile is the reference category), a homeowner dummy, a dummy variable for being married and a variable measuring household size. All estimated models account for age as well.

Women are on average in worse health than men. Woman's health advantages more from higher education than men. This even holds after controlling for economic resources. The results also suggests that economic variables as income and wealth are more protective for women's health than for men's health. A possible explanation is that poor health is in particular detrimental for household income when this affects the earning capacity of the main earner; women more often work part-time than men. Indeed when we account for labor market status the association between income and health disappears for men.

5.5 Conclusions

We construct a health measurement model where we combine survey data on SRH linked to a rich set of health measures from medical records. The estimated health model allows us to predict health for the population at large. We thereby account for unobserved heterogeneity and the persistence in unobserved health shocks by exploiting

that we have panel data on SRH at our disposal. To account for inconsistent reporting patterns in SRH over time we introduce a 'corrected' health measure. We show that this 'corrected' measure substantially increases the estimated persistence in health.

We use predicted health to study the evolution of health as individuals age and the interaction with economic variables and education. We find that people of low socio-economic status are more likely to stay in poor health —independent from the measure we use. Studies using SRH usually find a weaker pattern.

The age at which health starts to decline at a greater rate arrives earlier for males and persons with a lower level of education. Finally, we show that women on average are in worse health than men due to a higher prevalence of chronic diseases that have a relative detrimental effect on health. Women's health seems to benefit more from having higher education than men. We also provide evidence that income and wealth are protective of health over and above education. Since a woman's health deteriorates at a lower rate over the life-cycle then the health of men, their health status will converge.

These stylized facts are able to explain the variation in the decline in health status for different socio-economic groups which is also reported in other studies using SRH (e.g. Case and Deaton, 2005). However, we believe we find a somewhat higher level of decay for older persons than usually observed in studies using SRH.

5.6 Tables and figures

Table 5.1: Self-reported health for observations which can and cannot be linked to administrative records, $N = 24,486$

Self-reported health	Linked data	No linkage
Poor	0.9	1.4
Moderate	14.0	14.4
Good	60.1	59.6
Very good	19.5	18.9
Excellent	5.4	5.8

Table 5.2: Uncorrected and corrected self-reported health, $N = 16,720$

Self-reported health	Uncorrected	Corrected
Poor	0.9	1.1
Moderate	14.2	14.7
Good	60.4	59.8
Very good	19.2	19.1
Excellent	5.2	5.3

Table 5.3: Transition probabilities uncorrected and corrected self-reported health, $N = 16,720$

Panel A: Uncorrected health measure					
$t-1 \setminus t$	Poor	Moderate	Good	Very good	Excellent
Poor	46.8	46.8	6.4	0.0	0.0
Moderate	3.3	59.5	36.3	0.9	0.1
Good	0.2	8.3	78.6	11.7	1.3
Very good	0.1	1.6	37.3	51.6	9.5
Excellent	0.2	0.7	17.6	37.1	44.5

Panel B: Corrected health measure					
$t-1 \setminus t$	Poor	Moderate	Good	Very good	Excellent
Poor	70.6	25.7	3.7	0.0	0.0
Moderate	2.5	74.0	22.7	0.9	0.0
Good	0.2	5.7	88.4	5.3	0.5
Very good	0.1	1.3	16.6	78.4	3.6
Excellent	0.2	0.7	6.8	14.3	78.1

Table 5.4: Summary statistics, 2006, $N = 163,695$

	mean	sd	
Age	45.167	18.716	
Married	0.492	0.500	
Female	0.505	0.500	
Household size	2.709	1.400	
Primary education	0.032	0.176	
Secondary education, 1st stage	0.185	0.389	
Secondary education, 2nd stage	0.338	0.473	
University bachelor	0.278	0.448	
University master	0.167	0.373	
Owner occupied house	0.642	0.480	
Employed	0.579	0.494	
Job seeker	0.015	0.120	
Exempted from job seeking	0.020	0.139	
(Partial) disabled	0.031	0.172	
Retired	0.179	0.383	
Student	0.092	0.289	
No paid work	0.085	0.279	
Yearly net household income	35,395	25,829	
Total household wealth	202,004	673,287	
Distribution	p25	p50	p75
Yearly net household income	20,994	32,371	44,792
Total household wealth	9,724	90,494	244,892

Table 5.5: Prevalence of hospital care, homecare, prescription drug use and chronic conditions (based on prescription drug information)

	Men			Women		
	LISS	Admin	LISS	LISS	Admin	LISS
	Objective	Objective	Self-reported	Objective	Objective	Self-reported
Hospital care	15.72	14.24	9.37	19.59	19.30	11.61
Homecare	0.75	1.85	1.87	0.77	3.45	3.45
Prescription drug use	66.56	62.03	43.95	84.08	81.37	48.41
Coronary disease	12.45	11.43		7.26	9.14	
Epilepsy	1.54	1.41		1.88	1.83	
Cardiac disease	19.28	16.62	20.29	18.05	19.45	17.04
Inflammation and rheumatism	20.16	18.20	4.48	26.69	23.31	9.15
Hyperlipidemia	14.83	11.13	13.72	8.24	8.76	7.65
Malignancies	0.67	0.43		0.47	0.51	
Parkinson disease	0.64	0.45		0.56	0.54	
Diabetes	5.10	4.41	4.85	3.22	4.22	3.02
Glaucoma	1.53	1.41	1.53	1.11	1.35	1.11
Peptic acid disease	14.37	11.91	6.72	16.77	15.40	6.84
Respiratory illness, asthma	7.85	7.53	4.80	9.37	9.23	5.29
Thyroid disorders	1.00	0.86		4.66	4.01	
Crohn	0.49	0.51		0.68	0.59	
Pain	4.09	3.23		5.08	5.26	
Depression, anxiety	7.54	7.32	3.12	11.68	12.78	4.70

This table shows the prevalence of hospital care, homecare, prescription drug use and chronic conditions (based on prescription drug information). We distinguish between men and women in the LISS sample and the large random administrative sample. 'Objective' indicates the objective health measures in the administrative data and 'Self-reported' indicates the self-reported health measures in the LISS survey.

Table 5.6: Estimation results of the health index model, $N = 16,720$

	(1)		(2)	
	Chronic			
	Uncorrected		Corrected	
Parkinson's disease *	-0.589	0.060	-0.645	0.052
Diabetes	-0.578	0.029	-0.534	0.028
Osteoporosis and Paget disease				
Alzheimer, dementia and psychosis *				
Epilepsy *	-0.436	0.034	-0.416	0.028
Anxiety and depression	-0.337	0.014	-0.288	0.012
Malignancies	-0.288	0.054	-0.181	0.045
Cardiac disease	-0.282	0.015	-0.244	0.013
Respiratory illness, asthma	-0.274	0.016	-0.198	0.014
Thyroid disorders *	-0.269	0.031	-0.258	0.030
Chronic pain *	-0.250	0.019	-0.239	0.016
Stomach Ulcers	-0.218	0.013	-0.154	0.011
Coronary disease	-0.163	0.020	-0.171	0.018
High blood cholesterol	-0.137	0.019	-0.127	0.018
Migraine *				
Rheumatic conditions	-0.062	0.009	-0.051	0.008
Glaucoma	-0.027	0.043	-0.110	0.039
Tuberculosis	0.062	0.043	0.062	0.036
Hospital use	-0.121	0.011	-0.091	0.010
Home care	-0.150	0.046	-0.142	0.038
Prescription drugs use	-0.153	0.010	-0.090	0.008
$\lambda_{g1,1}$	-3.382	0.061	-3.109	0.057
$\lambda_{g1,2}$	-1.721	0.027	-1.566	0.027
$\lambda_{g1,3}$	0.392	0.024	0.508	0.025
$\lambda_{g1,4}$	1.347	0.033	1.556	0.036
$\lambda_{g2,1}$	-2.903	0.035	-2.590	0.032
$\lambda_{g2,2}$	-1.447	0.018	-1.312	0.018
$\lambda_{g2,3}$	0.434	0.016	0.484	0.016
$\lambda_{g2,4}$	1.445	0.021	1.559	0.022
$\lambda_{g3,1}$	-2.902	0.032	-2.703	0.031
$\lambda_{g3,2}$	-1.556	0.015	-1.428	0.014
$\lambda_{g3,3}$	0.272	0.012	0.323	0.011
$\lambda_{g3,4}$	1.276	0.014	1.335	0.014
$\lambda_{g4,1}$	-3.734	0.093	-3.453	0.092
$\lambda_{g4,2}$	-1.507	0.026	-1.264	0.026
$\lambda_{g4,3}$	0.449	0.025	0.515	0.026
$\lambda_{g4,4}$	1.463	0.038	1.500	0.038
$\lambda_{g5,1}$	-3.059	0.037	-2.773	0.035
$\lambda_{g5,2}$	-1.440	0.018	-1.273	0.017
$\lambda_{g5,3}$	0.521	0.016	0.577	0.016
$\lambda_{g5,4}$	1.412	0.021	1.494	0.022
γ	0.253	0.018	0.856	0.020
σ_c^2	0.602	0.009	0.161	0.112

For the threshold parameters we distinguish on basis of the variables 'gender' and 'year-of-birth' five different demographic groups ($G = 5$): (1) males born before 1945, (2) males born between 1945 and 1965, (3) individuals born after 1965, (4) females born before 1945, (5) females born between 1945 and 1965. * In column (4) we do not replace the indicated variables (*) by self-reported medical conditions because there is no information on these medical conditions in the LISS data.

Table 5.6: Estimation results of the health index model, $N = 16,720$

	(3) Chronic and inpatient treatment		(4)	
	Uncorrected		Uncorrected	
Parkinson's disease *	-0.563	0.059	-0.361	0.055
Diabetes	-0.588	0.029	-0.562	0.061
Osteoporosis and Paget disease	-0.437	0.040	-0.288	0.019
Alzheimer, dementia and psychosis *	-0.429	0.048	-0.365	0.060
Epilepsy *	-0.350	0.029	-0.414	0.034
Anxiety and depression	-0.313	0.014	-0.187	0.032
Malignancies	-0.210	0.037	-0.076	0.019
Cardiac disease	-0.272	0.015	-0.214	0.016
Respiratory illness, asthma	-0.273	0.016	0.009	0.044
Thyroid disorders *	-0.244	0.031	-0.248	0.019
Chronic pain *	-0.256	0.019	-0.248	0.023
Stomach Ulcers	-0.216	0.012	-0.598	0.030
Coronary disease	-0.177	0.019	-0.169	0.020
High blood cholesterol	-0.127	0.019	-0.506	0.019
Migraine *	-0.121	0.033	-0.357	0.024
Rheumatic conditions	-0.044	0.010	0.027	0.044
Glaucoma				
Tuberculosis				
Hospital use	-0.095	0.011	-0.194	0.012
Home care	-0.161	0.045	-0.124	0.024
Prescription drugs use	-0.158	0.010	-0.401	0.012
$\lambda_{g1,1}$	-3.367	0.060	-3.492	0.060
$\lambda_{g1,2}$	-1.717	0.027	-1.821	0.026
$\lambda_{g1,3}$	0.396	0.024	0.339	0.024
$\lambda_{g1,4}$	1.351	0.033	1.320	0.033
$\lambda_{g2,1}$	-2.900	0.035	-3.025	0.036
$\lambda_{g2,2}$	-1.445	0.018	-1.510	0.018
$\lambda_{g2,3}$	0.435	0.016	0.428	0.015
$\lambda_{g2,4}$	1.445	0.021	1.458	0.021
$\lambda_{g3,1}$	-2.895	0.033	-2.989	0.033
$\lambda_{g3,2}$	-1.553	0.015	-1.566	0.014
$\lambda_{g3,3}$	0.273	0.012	0.312	0.010
$\lambda_{g3,4}$	1.276	0.014	1.327	0.013
$\lambda_{g4,1}$	-3.803	0.090	-3.865	0.097
$\lambda_{g4,2}$	-1.534	0.026	-1.618	0.026
$\lambda_{g4,3}$	0.433	0.025	0.398	0.025
$\lambda_{g4,4}$	1.452	0.038	1.446	0.038
$\lambda_{g5,1}$	-3.055	0.037	-3.223	0.038
$\lambda_{g5,2}$	-1.440	0.018	-1.533	0.017
$\lambda_{g5,3}$	0.519	0.016	0.519	0.015
$\lambda_{g5,4}$	1.409	0.021	1.432	0.020
γ	0.248	0.018	0.256	0.018
σ_c^2	0.607	0.008	0.581	0.009

For the threshold parameters we distinguish on basis of the variables 'gender' and 'year-of-birth' five different demographic groups ($G = 5$): (1) males born before 1945, (2) males born between 1945 and 1965, (3) individuals born after 1965, (4) females born before 1945, (5) females born between 1945 and 1965. * In column (4) we do not replace the indicated variables (*) by self-reported medical conditions because there is no information on these medical conditions in the LISS data.

Table 5.7: In-sample predictions: 'uncorrected' and 'corrected' SRH, $N = 16,720$

$t \setminus t+1$	Poor	Moderate	Good	Very good	Excellent
Poor	36.2	56.3	7.5	0.0	0.0
Moderate	4.4	52.5	42.5	0.5	0.0
Good	0.1	10.7	74.3	13.7	1.2
Very good	0.0	0.4	43.9	43.3	12.4
Excellent	0.0	0.0	14.4	43.6	41.9
Poor	58.3	41.0	0.7	0.0	0.0
Moderate	4.5	66.7	28.8	0.0	0.0
Good	0.0	8.0	81.9	9.9	0.2
Very good	0.0	0.0	30.1	60.1	9.8
Excellent	0.0	0.0	1.9	37.0	61.1

Table 5.8: Health persistence by Educational Attainment, N=163,695

	$t \setminus t+1$	Poor	Moderate	Good	Very good	Excellent
Panel A: Uncorrected health measure						
Lower	Poor	36.7	55.6	7.6	0.0	0.0
	Moderate	5.1	50.5	43.8	0.6	0.0
	Good	0.2	12.0	74.2	12.5	1.2
	Very good	0.0	0.7	48.3	39.9	11.1
	Excellent	0.0	0.1	18.5	43.9	37.6
Higher	Poor	31.2	60.4	8.5	0.0	0.0
	Moderate	3.1	47.7	48.7	0.6	0.0
	Good	0.1	10.0	74.9	13.7	1.3
	Very good	0.0	0.5	46.8	40.8	11.9
	Excellent	0.0	0.0	16.8	44.6	38.6
Panel B: Corrected health measure						
Lower	Poor	50.1	47.7	2.2	0.0	0.0
	Moderate	4.8	60.2	35.0	0.1	0.0
	Good	0.1	10.2	78.9	10.6	0.3
	Very good	0.0	0.1	38.6	51.6	9.7
	Excellent	0.0	0.0	6.1	43.6	50.3
Higher	Poor	39.9	58.1	2.0	0.0	0.0
	Moderate	3.5	58.4	38.0	0.1	0.0
	Good	0.1	8.6	79.5	11.5	0.4
	Very good	0.0	0.1	37.1	52.8	10.0
	Excellent	0.0	0.0	5.4	44.2	50.4

Table 5.9: Health persistence by 2006 Income quintile, Uncorrected health measure, N=163,695

	$t \setminus t+1$	Poor	Moderate	Good	Very good	Excellent
Q1	Poor	39.5	53.0	7.5	0.0	0.0
	Moderate	6.1	51.8	41.6	0.5	0.0
	Good	0.3	13.2	73.6	11.9	1.1
	Very good	0.0	0.9	48.4	39.9	10.9
	Excellent	0.0	0.1	18.2	44.1	37.6
Q2	Poor	36.9	55.9	7.2	0.1	0.0
	Moderate	5.1	50.8	43.5	0.6	0.0
	Good	0.2	12.4	74.2	12.1	1.1
	Very good	0.0	0.7	49.2	39.2	10.9
	Excellent	0.0	0.1	18.9	43.9	37.2
Q3	Poor	33.3	57.7	8.8	0.1	0.0
	Moderate	3.9	49.1	46.4	0.6	0.0
	Good	0.1	10.9	74.7	13.0	1.2
	Very good	0.0	0.5	47.2	40.6	11.7
	Excellent	0.0	0.0	17.4	45.1	37.5
Q4	Poor	32.9	60.0	7.2	0.0	0.0
	Moderate	3.6	47.5	48.3	0.6	0.0
	Good	0.1	10.3	74.6	13.7	1.4
	Very good	0.0	0.6	47.5	40.4	11.6
	Excellent	0.0	0.1	17.8	44.0	38.1
Q5	Poor	28.1	62.5	9.4	0.0	0.0
	Moderate	3.1	48.2	48.1	0.6	0.0
	Good	0.1	10.0	75.0	13.6	1.3
	Very good	0.0	0.5	46.8	40.8	11.9
	Excellent	0.0	0.0	17.1	43.7	39.1

Table 5.10: Health persistence by 2006 Wealth quintile, Uncorrected health measure, N=163,695

	$t \setminus t+1$	Poor	Moderate	Good	Very good	Excellent
Q1	Poor	36.5	54.7	8.8	0.0	0.0
	Moderate	4.6	49.0	45.8	0.7	0.0
	Good	0.2	11.0	74.5	13.1	1.2
	Very good	0.0	0.6	47.3	40.7	11.4
	Excellent	0.0	0.0	17.5	44.5	38.0
Q2	Poor	39.3	54.0	6.7	0.1	0.0
	Moderate	5.2	50.4	43.8	0.6	0.0
	Good	0.2	11.9	74.2	12.5	1.3
	Very good	0.0	0.7	47.2	40.4	11.7
	Excellent	0.0	0.1	17.7	44.3	38.0
Q3	Poor	29.9	61.1	8.9	0.1	0.0
	Moderate	3.9	49.0	46.6	0.5	0.0
	Good	0.1	10.7	74.4	13.5	1.3
	Very good	0.0	0.6	47.7	40.2	11.5
	Excellent	0.0	0.0	18.0	45.2	36.8
Q4	Poor	35.5	55.7	8.8	0.0	0.0
	Moderate	4.2	49.6	45.7	0.5	0.0
	Good	0.2	11.4	74.6	12.6	1.3
	Very good	0.0	0.6	48.1	39.9	11.4
	Excellent	0.0	0.1	18.1	44.9	36.9
Q5	Poor	34.4	59.2	6.4	0.0	0.0
	Moderate	4.4	50.1	44.9	0.6	0.0
	Good	0.2	11.5	74.5	12.7	1.2
	Very good	0.0	0.6	48.5	40.0	11.0
	Excellent	0.0	0.1	17.7	42.0	40.2

Table 5.11: Estimation results, dependent variable: predicted health, N=163,695

	Men	Women	Men	Women	Men	Women
Intermediate education	0.083 ***	0.098 ***	0.064 ***	0.070 ***	0.056 ***	0.068 ***
Higher education	0.124 ***	0.175 ***	0.093 ***	0.126 ***	0.084 ***	0.121 ***
Married	-0.002	0.013 *	-0.011	-0.015 **	-0.013 *	-0.017 *
Household size	0.003	0.012	-0.005	-0.002	-0.004	-0.001
Homeowner			0.026 ***	0.010	0.022 **	0.005
2nd income quintile			0.018 *	0.048 ***	0.012	0.039 ***
3th income quintile			0.019 *	0.037 ***	0.006	0.025 **
4th income quintile			0.028 **	0.053 ***	0.011	0.038 ***
5th income quintile			0.022 *	0.080 ***	0.000	0.060 ***
2nd wealth quintile			0.032 ***	0.046 ***	0.026 ***	0.038 ***
3th wealth quintile			0.045 ***	0.045 ***	0.040 ***	0.038 ***
4th wealth quintile			0.069 ***	0.095 ***	0.064 ***	0.089 ***
5th wealth quintile			0.094 ***	0.137 ***	0.088 ***	0.130 ***
Retired					-0.056 ***	-0.065 ***
Unemployed					-0.045 **	-0.085 ***
Disabled					-0.348 ***	-0.314 ***
Self-employed					0.010	0.018
Other					0.020	-0.011
Constant	-0.169 ***	-0.369 ***	-0.195 ***	-0.384 ***	-0.183 ***	-0.359 ***

Significant at the *** 1%; ** 5%; * 10% level.

Table 5.12: Mapping prescription drugs to chronic conditions

Chronic disease	ATC-code in medical reg.	Matching variable LISS survey
Coronary disease	B01A, C04A	
Epilepsy	N03A	
Cardiac disease	C01, C03C	Heart or brain infarction, other heart diseases
Hypertension	C02, C03A, C07, C08, C09A,B	High blood pressure
Tuberculosis	J04A	
Rheumatic conditions	H02, M01, M02	Joint pain or joint infection
High blood cholesterol	C10A	High blood cholesterol
Malignancies	L01	
Parkinson's disease	N04B, N04A	
Diabetes	A10A, A10B	Diabetes
Glaucoma	S01E	
Stomach Ulcers	A02A, A02B	Heartburn
Respiratory illness, asthma	R03	Chronic bronchitis, asthma
Thyroid disorders	H03A, H03B	
Chronic pain	N02A	
Anxiety and depression	N05B, N06A	Anxiety or depression
Alzheimer, dementia, psychotic illness	N06D, N05A	
Osteoporosis and Paget's disease	M05	Osteoporosis (non-hormonal)
Migraine	N02C	Other pains (such as headache, backache)

Figure 5.1: Predicted health by age and gender

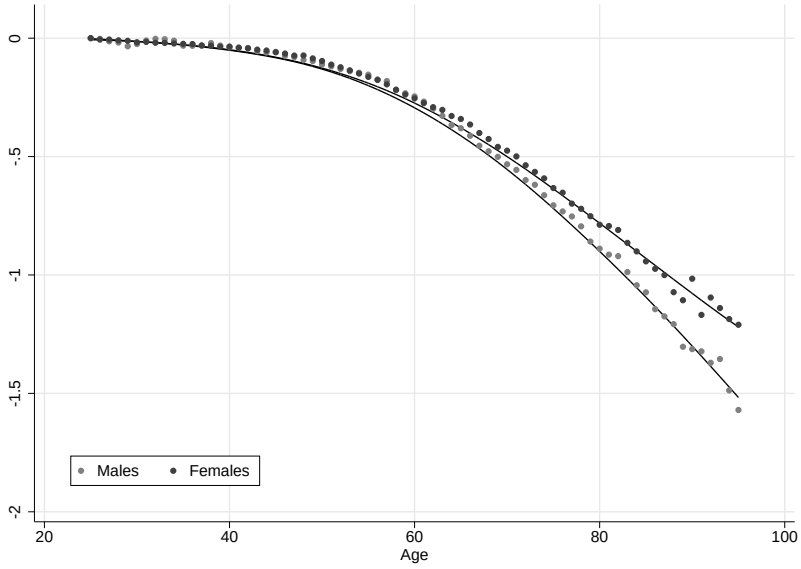


Figure 5.2: Predicted health by age and education - males

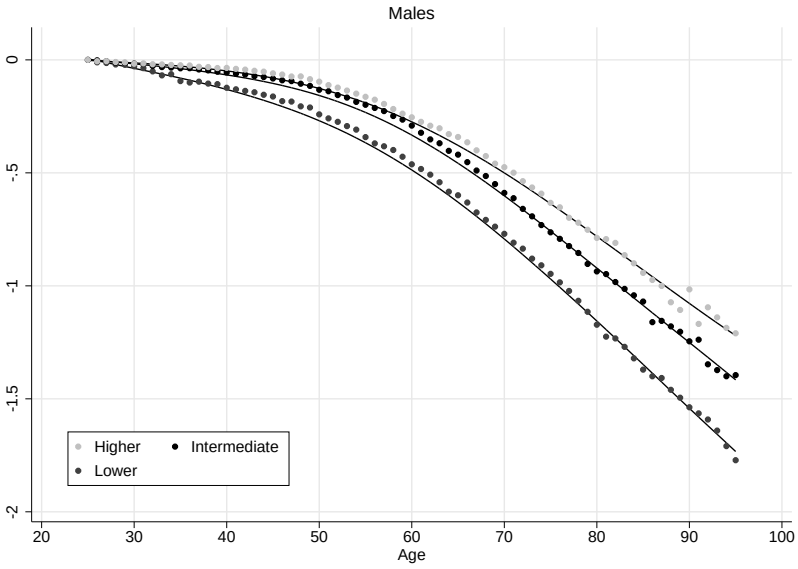
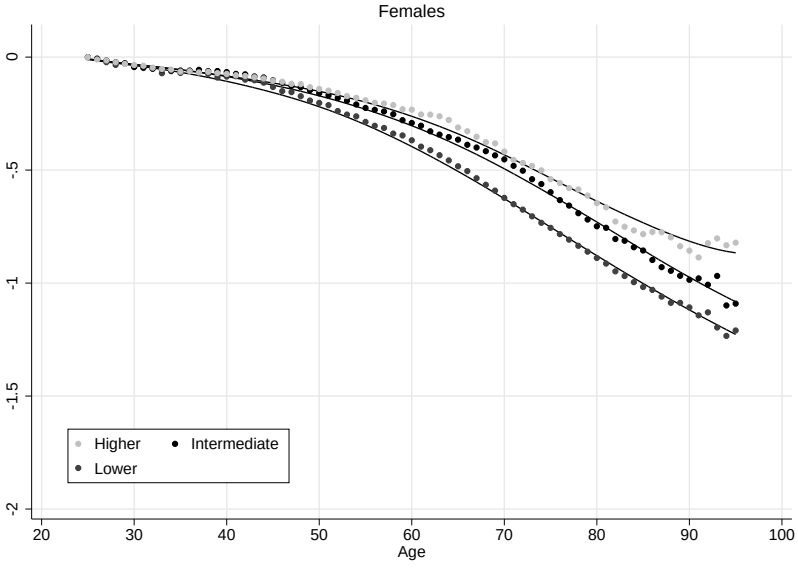


Figure 5.3: Predicted health by age and education - females



Chapter 6

Health, Lifestyle and Disability Transitions of Self-Employed Workers

6.1 Introduction

While most countries have compulsory public insurance for employees offering income protection in case of illness, income insurance for self-employed is optional and only available from private insurance companies in many European countries (Frick and Malo, 2008). Insurance companies play an important role in countries where income insurance for self-employed is organized privately instead of collectively. First, they decide whether or not to provide income insurance to self-employed and if so, against what premium level. From contract theory it is known that risk assessment generally plays a more important role in private than in public insurance due to adverse selection.[1] In the presence of adverse selection insurance companies offering income insurance engage in medical underwriting to obtain information about the riskiness of applicants. High-risk individuals might become subject to additional restrictions on the insurance (known as limited coverage) or have to pay a higher premium. In extreme cases they might even be denied coverage. Second, when a self-employed with income insurance receives disability benefits, it is the insurance company paying the benefits who has to decide about the best way to get the policyholder back to work. The insurance company's actions

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[1] Adverse selection arises when high-risk individuals are more likely to purchase insurance than low-risk individuals.

can vary between doing nothing and applying active insurance-based case management (Spierdijk et al., 2009). Insurance company's decisions about who to provide income insurance, for how long, under what conditions and against what premium level have important welfare implications.

Private income insurance has gained importance in the Netherlands after the abolishment of the compulsory public income insurance for self-employed workers as of August 2004. In 2008 about half of the Dutch self-employed labor force was privately insured against income loss due to disability (SER, 2010). Since the abolishment of the public income insurance for self-employed there have been serious concerns about the affordability of private income insurance among politicians, policymakers and self-employed. The main concerns are the high insurance premiums and the limited availability of income insurance for particularly high-risk groups of self-employed. Asymmetric information between the insurance company and the self-employed about the health and disability risks incurred by the latter can result in rising premiums, while potentially leaving healthy people without income insurance. Recent evidence suggests that the availability and expensiveness of income insurance may affect the decision to become self-employed (Heim and Lurie, 2010).

Self-employed workers play an important role in the economy by contributing to economic viability (e.g., Carree and Thurik, 2010; Koellinger and Thurik, 2012). Furthermore, self-employment provides an important pathway to retirement (Cahill et al., 2013). The European Union and various national governments have addressed the importance of self-employed workers and have been promoting self-employment (European Commission, 2004). Given self-employed workers' important role in the economy, limited availability and expensiveness of income insurance can have substantial welfare implications.

Bearing in mind the important role of insurers, the goal of this study is to analyze the relation between health and lifestyle habits and self-employed workers' entry into and exit out of disability using an insurance portfolio. The income insurance portfolio that we analyze belongs to the largest private insurance company of the Netherlands (Achmea) and covers both short-run and long-run (even permanent) disability, regardless of its cause (either work-related or not). Our unique data sample, covering the period 2005 – 2013, contains more than 20,000 income insurance contracts of Dutch self-employed workers and more than 5,500 approved disability claims of which about 85% were completed within the sample period.

According to the literature, health and lifestyle factors are important determinants of labor market outcomes in general and disability transitions in particular. We thus expect ill-health and bad lifestyle habits to have adverse effects on self-employed workers' disability outcomes, but at the same time we expect differences between the various

groups of policyholders. For example, we anticipate that bad lifestyle habits (such as smoking and being overweight) exacerbate the impact of physical and mental ill-health on disability outcomes. Similarly, we hypothesize that certain bad lifestyle habits exacerbate the influence of other bad lifestyle habits. We also expect differences between men and women (García-Gómez et al., 2010; Kapteyn and Meijer, 2013). Hence, the main contribution of this chapter is assessing the impact of health and lifestyle habits on disability outcomes across different subgroups of policyholders, such as smokers and non-smokers, overweight and normal-weight self-employed, and men and women. The subgroup analysis will reveal, for instance, whether the effect of ill-health on the risk of becoming disabled is stronger for heavy smokers than for non-smokers. We are not aware of any studies that analyze the interaction between bad lifestyle habits and ill-health, and its impact on disability outcomes.

Each disability claim in our portfolio is based on a medical certificate provided by a doctor, such that our analysis does not suffer from a subjective definition of disability. Information about health and lifestyle factors is available from the questionnaire that each self-employed completes upon buying income insurance. The lifestyle habits that we consider are smoking and drinking behavior, doing sports, and being overweight. We use a latent variable approach to predict an objective summary measure of physical health (e.g., Kapteyn and Meijer, 2013). We construct the latent measure of physical health on the basis of previously diagnosed physical health problems, which can be considered as relatively objective. Our analysis distinguishes between initial physical and mental health and allows the latter to have a different impact on disability transitions than the former (García-Gómez et al., 2010). We use previously experienced mental health problems as an indicator of initial mental health. This measure is based on the observation that many mental disorders are persistent and show high rates of recurrence (e.g., Spijker et al., 2002).

We investigate the impact of health and lifestyle habits on disability transitions using a mixed proportional hazards (MPH) approach, allowing for unobserved individual heterogeneity. In addition to health and lifestyle effects, we also correct for risk factors such as socio-demographic status (age and gender), occupational class, the type of disease causing the disability, cohort effects, and the properties of the insurance contract. We estimate separate MPH models for different subgroups of policyholders, such as smokers and non-smokers, overweight and normal-weight self-employed, men and women, and self-employed belonging to a specific occupational class. The subgroup analysis allows the observed risk factors to impact differently on the incidence and recovery rates of different groups and additionally permits group-specific unobserved heterogeneity. We test the hypothesis that certain bad lifestyle habits exacerbate the impact of other bad lifestyle habits and ill-health on disability outcomes. Furthermore, by estimating sepa-

rate MPH models for policyholders with different insurance contracts – such as those with limited coverage or a specific deferment period – we account for selection into specific types of insurance contracts on the basis of policyholders' unobserved risk factors (cf. Hill et al., 2013).

Physical ill-health, mental ill-health and bad lifestyle habits turn out to have adverse effects on the disability outcomes of self-employed workers with income insurance. Yet the main results of our study is that accurate assessment of the relation between health, lifestyle and disability outcomes requires a subgroup analysis that distinguishes several groups of policyholders (such as smokers and non-smokers, overweight and normal-weight self-employed, and men and women). The subgroup analysis is crucial because important differences between subgroups tend to vanish in an aggregate analysis. More specifically, we find that the impact of mental ill-health and smoking on the risk of becoming disabled is exacerbated by overweight, while the effects of physical ill-health, mental ill-health and overweight on recovery from disability are exacerbated by current and past smoking. Men and women differ in the way smoking and playing sports affect their risk of becoming disabled. Furthermore, they also differ in the way mental ill-health affects their risk of becoming disabled due to a mental disorder or severe conditions such as cancer. The results continue to hold after correction for other risk factors and selection effects with respect to the properties of the insurance contract. Moreover, the effects of health and lifestyle habits are both statistically significant and economically relevant.

The results of our case study can contribute to more effective criteria for risk selection and underwriting, the development of risk-based insurance premiums for income insurance, prevention of disability among self-employed, and optimization of their return-to-work process. The aforementioned discussion in the Netherlands about the affordability of private income insurance further emphasizes the need for our work.

The remainder of chapter is organized as follows. Section 6.2 provides a brief literature review and Section 6.3 describes the data. We discuss the empirical framework in Section 6.4. Sections 6.5 and 6.6 discuss the empirical results for transitions into and out of disability, respectively. Finally, Section 6.7 concludes.

6.2 Literature review: health, lifestyle and labor market outcomes

We review the literature that has analyzed the influence of health and lifestyle habits on labor market outcomes. We also consider the empirical literature that has analyzed the potential differences between self-employed and employees in terms of e.g. individual

characteristics, job characteristics and health status. Throughout, we provide a brief overview of some relevant studies, but do not attempt to be exhaustive in reviewing the huge amount of studies in this field.

The literature on sickness absence has shown that mental and physical ill-health have adverse effects on employees' disability transitions, in addition to the influence of other risk factors such as sociodemographic characteristics, disease category and severeness, economic incentives, educational attainment, job and company characteristics and macro-economic factors.[2] Furthermore, several studies have shown that bad lifestyle factors, such as smoking and drinking, have negative effects on employees' labor market performance in general (Van Ours, 2004; Morris, 2006). We are not aware of any studies that analyze the interaction between bad lifestyle habits and ill-health, and its impact on disability outcomes.

Self-employed form a special group in terms of individual characteristics such as risk-averseness, job characteristics, working conditions, job satisfaction, and remuneration methods (Tetrick et al., 2000; Bradley and Roberts, 2004; Beugelsdijk and Noorderhaven, 2005; Spierdijk et al., 2009). Some studies report that self-employed have more job control (Prottas and Thompson, 2006; Bjuggren et al., 2012), while others find that self-employed face higher levels of job demand and workload relative to employees (Buttner, 1992; Stephan and Roesler, 2010). Several studies have found that self-employed and employees differ in terms of health status (Tetrick et al., 2000; Bradley and Roberts, 2004; Stephan and Roesler, 2010). The literature has provided two possible explanations for this phenomenon: a contextual effect and a selection effect (Rietveld et al., 2013).

Existing studies analyzing disability among self-employed are scarce and have typically not analyzed the effect of health and lifestyle habits on self-employed workers' disability transitions (Hartman et al., 2003; Spierdijk et al., 2009; Richter et al., 2011; Spierdijk and Koning, 2014).[3] Furthermore, such studies have focused on self-employed workers' recovery from disability, while the present study also analyzes transitions into disability. Together, transitions into and out of disability provide a complete picture of the disability risks self-employed policyholders are exposed to.

The medical and epidemiological literature has typically analyzed the impact of health and lifestyle factors on disability outcomes of specific groups of wage workers (not self-employed), such as employees with low back pain or pregnant women. The general finding is that physical ill-health, mental ill-health and bad lifestyle habits have adverse

[2]See also, among others, Johansson and Palme (1996), and Knutsson and Goine (1998), Johansson and Palme (2002), Väänänen et al. (2003), Johansson and Palme (2005), Andrén (2007), Johansen et al. (2008), Bernström (2013), Arends et al. (2014), and Helgertz and Persson (2014).

[3]For completeness we notice that these two studies use totally different insurance portfolios than the present one.

effects on disability outcomes. The surveys by Duijts et al. (2007) and Beemsterboer et al. (2009) provide detailed overviews of the main findings in this field. Some recent studies in this rapidly growing research area are Ahola et al. (2008), Bratberg et al. (2009), Koopmans et al. (2011), Hjarsbech et al. (2011), Hystad and Bye (2012), and Knudsen et al. (2013).

Another important difference between our study and the existing literature is the young average age of the policyholders in our sample. Studies analyzing the relation between health and labor market outcomes have traditionally focused on older workers and their retirement decisions (e.g., Currie and Madrian, 1999; Van Ooijen et al., 2010; Kapteyn and Meijer, 2013; Insler, 2014), while we analyze a relatively young population (as will become apparent in Section 6.3). Only few studies analyze the impact of health on the labor market transitions of younger wage workers; see e.g. Contoyannis and Rice (2001), Dano (2005), García-Gómez and López-Nicolás (2006), and García-Gómez et al. (2010, 2013) and García-Gómez (2011). These studies establish both short-run and long-run effects of adverse health shocks on wages and entries into and exits out of employment and disability.

6.3 Data

Our sample consists of 21,755 income insurance policies sold by the largest private insurance company in the Netherlands (Achmea). The policies have a contract date between January 1, 2005 and December 31, 2010. 4,084 policyholder filed one or more valid disability claims during the period January 1, 2005 – June 30, 2013, resulting in 5,592 approved disability claims.

Our sample contains a few invalid disability claims, which we exclude from the sample. More precisely, 184 claims were invalid, which is only about 3% of the total number of claims. We have also deleted all claims due to pregnancy, since the corresponding durations are likely to be much more predictable than claim durations corresponding to other diseases (Spierdijk et al., 2009; Spierdijk and Koning, 2014).[4]

The income insurance that we consider covers both short-run and long-run (even permanent) disability, regardless of its cause (either work-related or not). Here disability is defined as the inability to work due to illness. This section provides more details on the properties of the disability insurance. We also provide a detailed data description and sample statistics of the insurance portfolio and the associated claims.

[4]Moreover, since 2010 female self-employed fall under a collective insurance for pregnancy in the Netherlands.

6.3.1 Questionnaire

Upon application, self-employed have to complete an insurance form with questions about health and lifestyle-related behavior. The questionnaire includes, among others, questions about self-employed workers' current health status and pre-existing medical conditions. The insurer applies medical underwriting criteria to decide about offering full coverage or limited coverage. Limited coverage means that one or more disorders are not covered by the offered insurance. In extreme cases the insurance company may deny coverage.

The questionnaire asks the applicants whether they currently have been experiencing any complaints or infirmities and whether they are currently on medication or follow a diet. They are also asked whether they are currently disabled. Based on their answers, we create an indicator variable for the presence of current health problems. This indicator variable has the value 1 if the respondent answers affirmative to at least one of these questions. One of the sample statistics reported in Table 6.1 is the sample mean of the indicator variable for current health problems ('curr.compl'). About 10% of the self-employed in the sample reports positive on current health problems. This percentage increases with age and equals 17.8% for self-employed whose age is between 45 and 55 years (not reported in the table).

The applicants are also asked whether they have ever experienced any specific health problems. The disease categories listed on the form are listed in Table 6.1 ('experienced health problems'). We create an indicator variable for each specific health problem. The most common previously experienced health problems are issues with the joints (48.6% for the total sample of claimants and non-claimants), skin problems (28.2%), back problems (19.4%), ear/nose/throat problems (15.9%), arms/neck/shoulder issues (14.9%) and mental disorders (11.0%).

In addition, the questionnaire contains health- and lifestyle-related questions, asking for height and weight, smoking and drinking behavior, and physical exercise. The questions about the intensity and duration of smoking and drinking are to be answered by the respondent in the form of an open-ended answer. In order to distinguish between current smokers and past smokers we use a parsing algorithm that identifies part of the string that is being answered. Reporting terms such as 'currently', 'still', 'until now' and similar are grouped in a indicator variable indicating current smokers. We also create indicator variables for past smokers, current drinkers, policyholders who play sports, and policyholders with overweight. The latter indicator variable is based on the policyholder's body mass index (BMI), which is calculated from its length and weight. Overweight is defined as a BMI exceeding 25, obesity as a BMI exceeding 30. About 20.3% of the policyholders reports being a current smoker, while 24.0% is a past smoker.

Approximately 86.9% of the self-employed reports positive on drinking alcohol, whereas 68.6% of the policyholders does sports. Almost 40% of the policyholders has overweight.

The questionnaire's information about policyholders' lifestyle habits is on a self-reported basis. The lifestyle questions in the questionnaire apply to fairly objective issues such as smoking, drinking, playing sports and being overweight, so comparability across respondents does not seem to be a problem here. There is, however, the possibility that policyholders who fear a high premium or exclusion from income insurance will not give honest answers to the lifestyle questions. There is contractual pressure to answer the questions honestly, though. In the insurance company's terms and conditions it is explicitly stated that dishonest or incomplete answers to the questions might lead to a denial of coverage in case of disability. Hence, because dishonest and incomplete answers can have serious financial consequences, self-employed have an incentive to fill in the questionnaire honestly and in complete detail. For both insurer and policyholder it is therefore common to assume *uberrima fides* on the part of the other side of the contract.

Besides information about policyholders' health and lifestyle habits, the answers to the questionnaire give information about insurants' socio-demographic characteristics (age and gender), occupational class (agriculture, technical and industrial, medical and paramedical, retail and wholesale, commercial and administrative, transport, care and services), and the terms of the insurance contract (full/limited coverage, the length of the deferment period and the level of the replacement income).[5] The complete list of remaining explanatory variables is given in Table 6.2.

Some explanatory variables deserve additional explanation. Self-employed with limited coverage are not fully insured against disability; i.e., certain illnesses and disorders are excluded from coverage. Usually the excluded diseases are the ones self-employed suffered from prior to or upon buying income insurance (known as preexisting conditions). The insurance company decides about granting either full or limited coverage to a self-employed. The replacement income is the annual income paid by the insurance company to the self-employed in case of 100% disability. The replacement income is bound to the insured's average annual three-year income prior to buying income insurance.[6] The deferment period is the waiting period prior to receiving replacement income. Only after expiry of this period the insurance company starts paying the replacement income to the self-employed. The deferment period allows the insurance company to determine the policyholder's health status more exactly and to prevent her from receiving replacement income for relatively minor health problems. The possible deferment

[5]The occupational class is derived from the ROA 2002 classification system. See the section 'Beroepen' in the document available at http://www.roa.unimaas.nl. [January 30, 2014].

[6]Our sample only provides information about the insured income in Euro and not about the insured income as a % of the policyholder's (average) annual income.

periods are 15 days, 1, 2, or 3 months, or 1, 2 or 3 years. The level of the replacement income and the length of the deferment period are chosen by the policyholder herself upon buying insurance. The insurance premium is inversely related to the deferment period and increases with the replacement income.

The average age of self-employed upon buying income insurance is almost 35 years, while the minimum and maximum ages are 16 and 60, respectively. The interquartile range of policyholders' age is $[28, 41]$ and only 5% of the policyholders is older than 50 years upon buying income insurance. Men constitute 84.8% of the sample, which we explain from the fact that many women in the Netherlands work only part-time. Because they are not the breadwinner, they probably do not consider it necessary to purchase income insurance. Another explanation for the low percentage of women in the sample is the dominance of technical/industrial and agricultural professions in our sample (31.0% and 13.4%, respectively). The annual replacement income has a sample mean of 34,042 Euro and its interquartile range is $[22,511; 40,000]$. Approximately, 21.3% of the policyholders has limited coverage. The most frequently chosen deferment period is 30 days, which applies to 50.2% of the insurance contracts in our sample. More detailed sample statistics are given in Table 6.2.

The sample statistics in Tables 6.1 and 6.2 highlight some notable differences between claimants and non-claimants in terms of playing sports, smoking, occupational class and characteristics of the insurance contract. The analyses in Sections 6.5 and 6.6 will provide formal evidence on the role of these risk factors in explaining disability transitions.[7]

6.3.2 Medical certificate

In the absence of disability, the health status of the policyholder is relatively constant, in the sense that she remains healthy enough to work as a self-employed. In case of disability, however, the policyholder's initial health status is updated accordingly, using the medical certificate corresponding to the disability claim.[8] The medical certificate, which is provided by a doctor, contains detailed information about the diagnosed disorder causing disability as mentioned on the accompanying medical certificate. The diagnosis is based on a classification scheme that is derived from the International Classification of Diseases ICD-10 developed by the World Health Organization.[9]

The bottom panel of Table 6.2 lists the indicator variables for the various ICD-10 diagnoses. In case of disability, the most frequently reported diseases in the ICD-10 medical

[7] For completeness we notice that our data sample does not contain any information about insurance premiums or about the self-employed who were denied coverage.

[8] Also lifestyle habits might change over time, but this is not very likely (e.g., Breslow and Enstrom, 1980).

[9] See http://apps.who.int/classifications/icd10. [January 30, 2014].

certificate are muscular-skeletal disorders (37.6%), injuries and poisoning (20.6%, with only a single case of poisoning), and mental disorders (12.1%). The main difference between muscular-skeletal disorders and injuries is that the latter have an external cause, such as an accident. The most frequently reported mental disorders are depression and burn-out. More sample statistics can be found in Table 6.2.

6.3.3 Data visualization

Figure 6.1 provides a visual overview of the data and the data collection process. We distinguish three states: the start of the insurance contract, disabled and non-disabled. Upon buying income insurance self-employed complete the aforementioned questionnaire, providing a wide range of explanatory variables that can be used to explain the policyholders' disability transitions. At the start of the insurance contract the self-employed is, per definition, non-disabled. Although a tiny percentage of the self-employed in the portfolio indicate that they are 'disabled' upon filling in the questionnaire (see Table 6.1), acceptance by the insurance company implies that the policyholder is able to work.[10] Because all self-employed start their contract as non-disabled, there is no initial conditions problem (Heckman, 1981). If self-employed become unable to work due to illness, they enter the state 'disabled'. In this case their initial health-status is updated accordingly, using the information about the ICD-10 diagnosis causing the disability. If a self-employed does not file a claim during the sample period, her duration until the first claim is right-censored. As soon as self-employed are able to resume work, they move to the state 'non-disabled'. If the sample period ends before a self-employed completes her disability spell, the resulting disability duration is marked as right-censored. Because the sample of disability durations is an inflow sample, there is again no initial conditions problem. Self-employed can file multiple disability spells during the sample period.

Figure 6.1 also provides sample statistics. 18.8% of the 21,755 policyholders files one or more valid disability claims during the sample period that starts on January 1, 2005 and ends on June 30, 2013. About 16.7% of the disability durations is right-censored, which means that those spells do not end before the aforementioned end date. The average number of claims per claimant equals 1.37. Claimants' average duration until their first disability claim is 909 days (2.5 years), while the median of this duration equals 791 days (2.2 years). The claimants' average duration until recovery from disability is 262 days (0.7 years), which is much larger compared to the median duration of 115 days (0.3 years). The difference between mean and median disability duration indicates that there are several cases of long-term disability. This is explored

[10] The results of the remaining analysis are not affected by leaving out this small group of policyholders.

in more detail in Figure 6.2, which displays two unconditional Kaplan-Meier survival functions, representing the probability that a duration exceeds a certain number of days. The survivor function of the duration until the first claim is relatively flat. After 3 years only 10% of the policyholders have filed a claim. The survivor function of the disability duration declines very steeply until about 150 days of disability, when about 60% of the disability claims have already been followed by recovery. The survivor function flattens out after about 3 years of disability, indicating that recovery is unlikely to occur after this period.

Our sample contains some missing information about the type of insurance contract. For 1,286 out of 21,755 claims the information about limited coverage and/or the deferment period is missing. We will later deal with this by estimating models using slightly reduced samples.

6.3.4 Measuring initial physical and mental health

To examine the effect of a self-employed's initial physical health on her disability transitions, we need an objective summary measure of initial physical health. To avoid multicollinearity and to facilitate the interpretation of marginal effects we do not want to use all health-related variables in our models (Bound et al., 1999). Furthermore, there are concerns about the validity of self-reported health measures as an indicator of current health to assess the impact of health on disability outcomes; see for example Bound (1991) and Kalwij and Vermeulen (2008). The main concern is that subjective judgements about someone's own health status might not be entirely comparable across respondents. Lack of comparability between individuals will result in measurement error, which might lead to underestimation of the effect of health on disability outcomes.

To deal with these issues, we estimate the comprehensive measure of initial physical health as a function of relatively objective indicators of health: the previously experienced physical health problems that have been reported in the questionnaire. The underlying idea is that these objective indicators of health are not influenced by reporting bias.

We use a probit model to estimate the latent physical health index, which is in line with the existing literature (e.g., Bound, 1991; Bound et al., 1999; Lindeboom and Kerkhofs, 2009; García-Gómez et al., 2010; Jones et al., 2010; Kapteyn and Meijer, 2013). The relatively subjective indicator for current physical health problems ('curr.compl'), as introduced in Section 6.3.1, is used as the dependent variable in this model. This indicator variable has the value 1 if the self-employed reports health problems upon buying income insurance. The (relatively objective) explanatory variables are related to the

previously experienced physical health problems that are reported by the self-employed upon buying income insurance; see Table 6.1. The resulting latent health index is rearranged in percentiles, where the first percentile represents the best health and the 100th percentile the poorest health. The interpretation of the latent health index is that it is the conditional expectation of current physical ill-health given previously experienced physical health problems.

The estimation results for the probit model can be found in the appendix. Most coefficients are significant and have the expected positive sign, while the probit model's pseudo R^2 equals 17.4%. We calculate the average values of the probit-based latent physical health measure for different subgroups of policyholders. Self-employed who report no health problems upon buying income insurance have an average value of 47.0, while individuals with health issues have an average value of 77.2. Smaller differences in initial health exist between claimants (52.2) and non-claimants (49.5). Moreover, individuals with limited coverage have an average health index of 61.5, while those with full coverage have an average health index of 46.7. Self-employed with limited coverage also report more current health problems than policyholders with full coverage (19.5% versus 7.3%) and more frequently report past health problems. On average men are in better initial physical health than women. Their average health scores equal 48.9 and 56.3, respectively. Women also report more current health problems than men (12.1% versus 9.7%), and also report more previously experienced health problems.

Our analysis distinguishes between initial physical and mental health and allow mental health to have a different impact on disability transitions than other dimensions of health; see García-Gómez et al. (2010) who also make this distinction in their study of labor market transitions. We use previously experienced mental health problems as an indicator of initial mental health. The indicator variable for mental health health problems takes the value 1 when the policyholder reports any previously experienced mental health problems in the questionnaire upon buying income insurance. The indicator for mental health is motivated by the observation that many mental disorders are persistent and show high rates of recurrence (e.g., Spijker et al., 2002).

Because physical health, mental health and lifestyle habits are measured upon buying income insurance, they are predetermined with respect to the subsequent disability transitions. By contrast, some studies measure both the onset of disability and health problems around the same time (e.g., Johansson and Palme, 1996).

6.4 Methodology

This section discusses the empirical framework for modeling the impact of health and lifestyle habits on entries into and exits out of disability.

6.4.1 Mixed proportional hazard model

The focus of this study is on the hazard rates corresponding to self-employed workers' entries into and exists out of disability. Hazard rates are particularly suitable to deal with censored and truncated data. We are interested in the incidence-of-disability rate and the recovery-from-disability rate. We will henceforth refer to these hazard rates as the 'incidence rate' and the 'recovery rate'. The incidence rate is based on self-employed workers' duration until the first disability, while the recovery rate is derived from the disability durations. Both durations are potentially right-censored. We are mainly interested in the way these two hazard rates are affected by risk factors related to health and lifestyle habits.

The disability rate reflects the risk of becoming disabled at time t, conditional on no disability until time t. We use a mixed proportional hazard (MPH) model to specify the disability rate. The MPH model has been shown to be particularly suitable for modelling durations in economics and has been widely used in other studies in the field (Van den Berg, 2001). The MPH model is of the form

$$\lambda^D(t \mid X, v) = \lambda_0^D(t) \exp(X'\beta_D + v), \tag{6.1}$$

where X is a K_D-dimensional vector of observed covariates (where D stands for 'disability'), β_D a vector of coefficients of the same dimension, and $\lambda_0^D(\cdot)$ the baseline hazard. Moreover, v reflects individual-specific unobserved heterogeneity, which can be interpreted as a function of unobserved explanatory variables (Van den Berg, 2001).

Similarly, the recovery rate reflects the rate of recovery at time t, conditional on no recovery until time t. We also use a MPH model to specify the recovery rate:

$$\lambda^R(t \mid Z, w) = \lambda_0^R(t) \exp(Z'\beta_R + w), \tag{6.2}$$

where Z is a K_R-dimensional vector of observed covariates (where R stands for 'recovery') containing possibly (but necessarily) different covariates than X, β_R a vector of coefficients of the same dimension, and $\lambda_0^R(\cdot)$ the baseline hazard. Moreover, w reflects individual-specific unobserved heterogeneity.

Throughout, we account for unobserved individual-specific heterogeneity to capture any omitted variables related to e.g. education, risk aversion, and individual workplace heterogeneity. Unobserved heterogeneity, when not taken into account, affects the shape of the baseline hazard function and may lead to a downwards bias in the estimated model coefficients and duration dependence; see e.g. Kalbfleisch and Prentice (2002). More details about unobserved heterogeneity will be provided in Section 6.4.2.

The single-spell and multi-spell MPH models are non-parametrically identified under

the assumptions listed in Van den Berg (2001); see also Honoré, 1993 for MPH models. In the single-spell case these assumptions include the requirement that there is at least one continuous covariate and that the unobserved heterogeneity is independent of the covariates.

Health and lifestyle conditions are likely to impact differently on the hazard rates associated with different disorders. For example, a poor mental health is likely to have a large impact on the occurrence of mental problems and a less substantial effect on physical impairments such as fractures. We therefore estimate a competing risks version of the MPH model for disability incidence, distinguishing between different disorders causing the disability (e.g., Markussen et al., 2011). We therefore adopt an independent competing risks approach. The hazard rate corresponding to the m-th competing risk equals

$$\lambda_m^C(t \mid X, u) = \lambda_0^m(t) \exp(X'\beta_C^m + u), \tag{6.3}$$

where β_C^m is a vector of coefficients of dimension K_D, $\lambda_0^m(\cdot)$ the baseline hazard and u the individual-specific unobserved heterogeneity.

6.4.2 Unobserved heterogeneity

We follow the standard approach in the economic literature to model dependence among multiple durations and assume that, conditional on the observed covariates and the unobserved heterogeneity, a policyholder's duration until the first claim is independent of any subsequent disability spells (Van den Berg, 2001, Section 8.1). Similarly, we assume that, conditional on the observed covariates and the individual-specific unobserved heterogeneity, multiple disability durations corresponding to the same policyholder are independent. Conditional on the observed covariates only, however, durations of the same policyholder are *dependent* due to the related unobserved determinants. Note that the relation between the durations of the same policyholder is spurious to the extent that it only follows from the unobserved heterogeneity. Durations of different policyholders are independent.

Throughout, we assume a Weibull baseline hazard (allowing for constant, increasing, or decreasing duration dependence) and a discrete Heckman-Singer frailty distribution with an endogenous number of mass points (Heckman and Singer, 1984). Heckman-Singer frailty is a non-parametric way of modeling unobserved heterogeneity. The frailty probability distribution in the incidence model satisfies $\mathbb{P}(v = v_i) = p_i$, where $\sum_{i=1}^{N} p_i = 1$ in case of a Heckman-Singer frailty distribution with N mass points (where the appropriate value of N is determined by the Heckman-Singer procedure). Later we will run robustness checks using partial likelihood and gamma frailty, while leaving the

baseline hazard unspecified.

We estimate the hazard rates for disability incidence and recovery separately using marginal maximum likelihood (ML), resulting in estimates of β_D, β_R, $\lambda_0^D(\cdot)$, $\lambda_0^R(\cdot)$ and the marginal frailty probability distributions $f(v)$ and $g(w)$. For the independent competing risks approach we estimate separate MPH models for the various competing risks, yielding estimates of β_C^m, $\lambda_0^m(\cdot)$ and the frailty distributions $h_m(u)$, for each m. The appendix provides explicit expressions for all log-likelihood functions estimated in this study.

Additional efficiency can be achieved by joint ML estimation of the incidence and recovery rates as specified in Equations (6.1) and (6.2), resulting in a multivariate MPH model (Van den Berg, 2001). Joint estimation requires explicit assumptions about the specific form of the joint frailty probability distribution $k(v, w)$. For example, one can assume two shared frailty terms in both the incidence and recovery rates, combined with a two-factor loading (Van den Berg, 2001). Because the benefit of additional efficiency due to joint estimation is offset by the need for additional distributional assumptions and the substantial increase in computational complexity, we confine our main analysis to marginal ML estimation of the incidence and recovery rates.

6.4.3 Selection effects

Our insurance portfolio is potentially subject to health-related selection into self- employment (see e.g. Rietveld et al., 2013), adverse selection and risk-selection by the insurance company. Furthermore, the policyholders are relatively young, with an average age of 35 years upon buying income insurance. Because the insurance portfolio consists entirely of relatively young self-employed with disability insurance, it is not possible to disentangle, analyze or control for the aforementioned selection effects. Our analysis is conditional on the selection, which is a common feature of studies using insurance data (e.g. Spierdijk et al., 2009; Spierdijk and Koning, 2014). A conditional analysis like ours is still relevant from an insurance perspective, because it can contribute to more effective criteria for risk selection and underwriting, the development of risk-based insurance premiums for income insurance as described in Spierdijk and Koning (2014), prevention of disability among self-employed, and optimization of their return-to-work process.

We do control for selection with respect to the generosity of the insurance contract though. Our sample contains policyholders with different types of insurance contracts. The contracts may differ in terms of full/limited coverage, the length of the deferment period and the level of the replacement income. Since the different types of income insurance contracts are not randomly assigned to self-employed, significant unobserved

differences could arise between policyholders with different income insurance contracts (Hill et al., 2013). For example, self-employed with different deferment periods may also differ in terms of unobserved risk factors (Cox and Gustavson, 1995). Individuals choosing a short deferment period are possibly more risk averse than those opting for a longer waiting time (Spierdijk et al., 2009). Pooling policyholders with long and short deferment periods could therefore bias the estimation results. Throughout, we account for selection on the basis of policyholders' unobserved risk factors by estimating separate MPH models for different subgroups of policyholders, such as those with limited coverage or a specific deferment period.

Similarly, we estimate separate MPH models for self-employed with different lifestyle habits (such as smokers and non-smokers), for men and women, and for self-employed belonging to a specific occupational class. Estimating separate MPH models for different subgroups allows for group-specific unobserved heterogeneity and additionally permits the observed risk factors to impact differently on the incidence and recovery rates of different groups.

Another form of selection arises when policyholders leave the sample because they do not want to continue their insurance policy (lapsing) or because they die. We deal with this form of selection by marking the relevant durations as censored.

6.5 Transitions into disability

This section uses survival analysis to assess the impact of health and lifestyle habits on self-employed workers' transitions into disability.

6.5.1 Full sample

We estimate a MPH model for the duration until the first claim. The corresponding incidence rate is specified as in Equation (6.1). Apart from initial physical and mental health, we also correct for policyholders' socio-demographic characteristics (age and gender), occupational class (agriculture, technical and industrial, medical and paramedical, retail and wholesale, commercial and administrative, care and services), the characteristics of the insurance contract (full/limited coverage, deferment period, replacement income), and cohort effects (using time dummies based on the year in which the insurance policy was bought).[11] The policyholder's age enters the model both linearly and quadratically to capture any nonlinearities. To account for cohort and time-fixed effects, caused by e.g. institutional changes, changes over time in the business cycle

[11] Due to the small percentage of policyholders working in the transport sector, we have aggregated this occupational class with technical and industrial professions.

and changes in the conditions of the insurance policy, we include cohort dummies for the year in which the insurance policy was bought.

Throughout, we focus on the impact of health and lifestyle habits on the risk of becoming disabled. For completeness we also report the effects of age and gender here.[12]

The estimation results can be found in first panel of Table 6.3, captioned 'all disorders'. The estimates in the column captioned '$\exp(\beta_D)$' reflect hazard ratios, which boil down to the exponentiated coefficients. They reflect the change in the hazard rate due to a ceteris paribus unit increase in one of the explanatory variables. They facilitate interpretation of marginal effects. For the gender dummy, for example, the hazard ratio expresses the hazard rate of a male self-employed as a percentage of the hazard rate of a comparable female self-employed. For continuous covariates, such as age, the hazard ratio expresses the hazard rate of somebody aged $n+1$ as a fraction of the hazard rate of somebody aged n, ceteris paribus.[13]

Initial physical ill-health leads to a significantly higher risk of entering disability in a later stage, ceteris paribus. A self-employed with a latent physical health score of 75 has a 12% higher risk of becoming disabled than a policyholder with initial health score 50. Persons who experienced mental health problems prior to buying income insurance have a 26% higher incidence rate than persons who did not experience such disorders. Hence, the effect of poor mental health is equivalent to a deterioration in physical health of more than 50 percentage points. The effects of initial physical and mental ill-health are significant at the 1% level. Smokers have a 22% higher risk of entering disability; an effect that is significant at the 1% level. The distinction between current and past smoking is important, because the increased risk of becoming disabled only applies to current smokers and not to past smokers. We do not find significant effects for being overweight, playing sports and drinking alcohol.[14] There is a large and highly significant difference in disability risk between men and women. Men have a 36% lower risk of becoming disabled than women. The significant gender effect may be caused by large differences between men and women in living conditions, lifestyle, education, family situation, social network, violence, and total (paid and unpaid) workload (Alexanderson et al., 1996). As expected, old age goes hand in hand with a significantly higher risk

[12]The effects of the remaining risk factors and a detailed interpretation are available upon request.

[13]Throughout, we scale all durations by a factor 100 to avoid hazard rates that become too small in the numerical optimization of the MPH models. This scaling only affects the scale of the estimated frailty mass points.

[14]The answers to the open-end questions about the self-employed workers' smoking and drinking behavior allow us to refine the information for some policyholders, for example by considering the amount of cigarettes smoked per day. Unfortunately, not all self-employed complete the open questions with the same amount of detail, due to which the refined variables contain many missing values. We therefore only use the indicator variables for drinking, smoking and playing sports.

of becoming disabled, but the relation between age and disability risk is non-linear.[15] It follows a parabola that opens upward. The disability risk is lowest around the age of 25. Unobserved heterogeneity is captured by a Heckman-Singer frailty distribution with two mass points, which divides the sample into self-employed with favorable (84% of the sample) and unfavorable (16%) unobserved risk factors.

We establish increasing duration dependence, indicating that the risk of becoming disabled increases with the time elapsed since the start of the insurance contract. This result will turn out robust across all specifications estimated.

6.5.2 Subgroup estimations: good vs. bad lifestyle habits

To test whether certain bad lifestyle habits exacerbate the impact of other bad lifestyle habits and initial health on the risk of becoming disabled, we estimate the MPH for the incidence rate separately for the following subgroups of workers: (1) policyholders who have never smoked and those who currently smoke or smoked in the past; (2) overweight and normal-weight policyholders; (3) policyholders who drink and those who don't; (4) policyholders who play sports and those who don't. By estimating separate MPH models for different subgroups, we allow for group-specific unobserved heterogeneity and additionally permit the observed risk factors to impact differently on the incidence rates of these groups.

The subgroup estimations show that being overweight is the only lifestyle factor that exacerbates the relation between health, lifestyle and disability incidence. The estimation results for normal-weight and overweight policyholders are shown in Table 6.4.[16] Overweight exacerbates the effect of mental-ill health on the risk of becoming disabled. For normal-weight policyholders initial mental health does not significantly affect the risk of becoming disabled. By contrast, for overweight policyholders this variable is highly significant, implying that mental ill-health is an important risk factor for the onset of disability among overweight policyholders. These outcomes suggest that the significance of initial mental health as established in the MPH model applied to all policyholders (see Section 6.5.1) is due to those who are overweight and emphasize the importance of the subgroup analysis. The interrelatedness of overweight and mental health problems is well-known from the medical literature (e.g., Larsson et al., 2002) and now turns out to affect disability incidence as well. We emphasize that these results are not driven by the group of obese policyholders. They continue to hold when we leave out the latter group of self-employed and only consider overweight policyholders whose bodymass index is between 25 and 30.

[15] In all models the two age coefficients are jointly significant according to a Wald test.

[16] The estimation results for the other lifestyle subgroups are omitted to save space, but available upon request.

Several other results emerge from Table 6.4. Smoking does not significantly affect the incidence rate of policyholders with a normal weight, while for overweight policyholders this variable is highly significant. The latter finding suggests that the adverse effect of smoking on disability incidence driven by the group of overweight policyholders. The coefficient of initial physical health has a relatively high magnitude in the model for policyholders with a normal weight; it is even significantly larger than in the model for overweight policyholders according to a Wald test. A possible explanation is that the dominance of mental health problems masks the onset of physical health problems in the group of overweight policyholders.

6.5.3 Subgroup estimations: gender, generosity of the insurance contract, occupational class

The literature has shown that the effects of health on labor market transitions might differ across men and women (García-Gómez et al., 2010; Kapteyn and Meijer, 2013). Furthermore, male and female self-employed might also differ in terms of unobserved heterogeneity. We therefore estimate the MPH model separately for men and women; see the first panel (men) and the second panel (women) of Table 6.5. The effect of initial physical and mental health is significant for both men and women, but for women the two effects are significant at the 5% level only. The reduced significance for women is likely due to the relatively modest percentage of women in the portfolio (15%). The magnitude of the effect of initial physical and mental health does not significantly differ across male and female self-employed workers, according to a Wald test. We establish gender differences in the way smoking and playing sports affects the risk of becoming disabled though. For men, the risk of becoming disabled is 24% higher for smokers than for non-smokers; this effect is significant at the 1% level. Yet there is no significant difference in disability incidence between smoking and non-smoking women. Of the 15% women in our sample, only about 16% reports positive on being a current smoker, which might be insufficient to establish a significant effect for smoking. Another explanation is that women may smoke less than men. Another gender difference relates to the impact of playing sports on becoming disabled. Although playing sports does not significantly affect the risk of becoming disabled for men, it does for women. Female self-employed who do sports have a 21% lower risk of entering disability; an effect that is significant at the 10% level. A possible explanation is that women do different types of sports than men (e.g., sports with less injury risk) or that they exercise more frequently than men. We will come back to this issue later in Section 6.5.4. We emphasize that the estimation results for men and women do virtually not change when we allow for gender-specific measures of initial physical health.

Self-employed with limited coverage are not fully insured against disability. Usually the disorders excluded from coverage are the ones that the self-employed suffered from prior to or upon buying income insurance. Our sample only contains policyholders' claims that are not excluded from coverage. In Section 6.3.4 we reported that self-employed with limited coverage report more current health problems than policyholders with full coverage (19.5% versus 7.3%) and that they also experience more previously experienced complaints. For example, self-employed with limited coverage more frequently report previously experienced mental complaints than policyholders with full coverage (21.7% versus 7.9%). Moreover, the former group has a worse initial physical health than the latter group (61.5 versus 46.7). Policyholders with limited and full coverage may also differ in terms of unobserved risk factors. We now present a more formal analysis by estimating separate MPH models for the two groups; see the third panel (full coverage) and fourth panel (limited coverage) of Table 6.5. The coefficient of initial physical health remains significant when the sample is restricted to those with limited coverage (albeit at the 5% level), while the effect of previously experienced mental health problems is no longer significant. The insurance company's risk selection on the basis of previously experienced mental health becomes apparent here: for self-employed with limited coverage the risk of becoming disabled is not significantly related to their initial mental health. Yet initial physical health significantly affects the risk of becoming disabled for those with limited coverage and the magnitude of this effect does not significantly differ from those with full coverage. We also observe that the effect of smoking is no longer significant for the group with limited coverage. This suggests that heavy smokers, with a high risk of developing health problems due to smoking, have been given limited coverage.

The sample statistics show that self-employed with a short/medium deferment period tend to differ from policyholders with a long deferment period mainly in terms of the occupational class and only marginally in terms of other observed risk factors such as initial health. The percentage of self-employed with an agricultural profession is particularly high among those with a long deferment period, while the percentage of technical and industrial professions is relatively low. As noted in Spierdijk et al. (2009), self-employed with different deferment periods may also differ in terms of unobserved risk factors. Another complication related to the deferment period is that policyholders with a longer deferment period might not always report their illness to the insurance company when the illness is not expected to lead to a disability duration in excess of the deferment period, resulting in selection effects with respect to the severeness of the claims filed. We investigate the consequences of these issues in more detail by estimating a separate MPH model for policyholders with a 1-month deferment period. This relatively homogenous group covers 50.2% of the total sample. The estimation results in the

first panel of Table 6.6 (captioned '1-month deferment period') differ only marginally from the full sample results reported in Table 6.3. The lack of notable differences suggests that selection on the basis of unobserved characteristics and underreporting of minor health problems has only little impact on the estimation results.

The second panel of Table 6.6 (captioned 'technical and industrial professions') displays the estimation results for the MPH model applied to policyholders with technical and industrial professions. Technical and industrial professions are the largest occupational class in our sample with 31% of the policyholders belonging to this group. Again, the subsample and full-sample estimates are similar.

We re-estimate all MPH models for the incidence rate and include interaction terms between the lifestyle indicators and the measures for physical and mental health. This extended specification allows bad lifestyle habits and physical and mental ill-health to exacerbate each other's effect on the risk of becoming disabled. In several models the interaction between the indicators for overweight and initial mental health problems turns out significantly positive. This is the case in the model for men and in the model for policyholders with limited coverage. In these two models overweight and mental ill-health exacerbate each other's effect on the risk of becoming disabled. Furthermore, we observe that the indicator for mental health problems loses its significance in the presence of the interaction variable in the model for male policyholders. The latter finding suggests that the adverse effect of mental ill-health on disability incidence among men is driven by the group of overweight policyholders.

6.5.4 Competing risks approach

The results until sofar have revealed a significant impact of initial physical and mental health on transitions into disability. We expect that initial health will have a less substantial influence on minor complaints than on more severe disabilities. Similarly, we expect initial mental health to be a very important predictor of disability due to mental problems. We therefore continue the analysis with independent competing risks models (e.g., Van den Berg, 2001). In our specific setting competing risks models boil down to MPH model applied to self-employed who enter disability due to a specific disorder; see also Markussen et al. (2011).

Because certain disorders are observed relatively infrequently, we cannot estimate separate MPH models for each specific ICD-10 disorder. We therefore restrict the competing risks analysis to three main categories. We first estimate a separate MPH model for self-employed who become disabled due to mental disorders (such as depression and burn-out). We also estimate a separate MPH model for policyholders who enter disability due to muscular-skeletal disorders, injury and poisoning (henceforth referred to

as physical impairments, since poisoning occurs only once in our sample). This disease category encompasses disorders such as a fractured ankle and low back pain. Finally, we estimate a MPH model for policyholders who enter disability due to severe conditions (including cancer, diseases of blood and blood-forming organs, circulatory disorders, endocrine and nervous diseases); see Smith (2004) who identifies severe conditions in a similar way.

Section 6.5.1 has shown that initial physical and mental ill-health, as well as being a smoker, significantly increases the risk of entering disability on the aggregate level. Panels 2 – 4 of Table 6.3 refine these results.[17] There is considerable heterogeneity in terms of the disorder causing the disability. Physical ill-health, mental ill-health, smoking and a lack of physical exercise significantly increase the risk of entering disability due to a mental disorder. The positive effect of playing sports on disability outcomes (which is significant at the 10% level) is in line with results reported in the medical literature (e.g., Duijts et al., 2007; Hendriksen et al., 2010). It is also consistent with studies showing that physical exercise has a positive influence on avoiding depression (e.g., Mammen and Faulkner, 2013). The influence of physical exercise is not merely positive though. Doing sports increases the risk of becoming disabled due to physical impairments by 15%. This effect is significant at the 5% level. Since physical impairments include injuries such as a fractured ankle, this effect is likely to reflect sports injuries.

The economic relevance of the aforementioned health and lifestyle effects is substantial. An increase in the physical health score of 25 percentage points results in a 8.5% drop in the incidence rate of mental disorders; self-employed whose experienced mental disorders in the past have a 74% higher incidence rate than individuals who did not; smoking increases the risk of becoming disabled by 42%; and playing sports reduces the risk of entering disability due to a mental disorder by 17%. As expected, the effect of initial mental health on the risk of becoming disabled due to a mental disorder is significantly higher than the effect of initial mental health on the overall incidence rate. This confirms evidence from the medical literature that mental disorders tend to be persistent and recurring (e.g., Spijker et al., 2002).

Several other effects are worth mentioning. Initial physical ill-health significantly increases the disability risk due to physical impairments: an increase in the physical health score of 25 percentage points results in a 10% rise in the incidence rate. The risk of entering disability due to severe conditions is not significantly affected by previously experienced mental health problems, but is significantly increased by initial physical ill-health. As before, drinking alcohol does not have significant impact on the risk of becoming disabled.

[17] The complete estimation results are available upon request.

Smoking significantly increases the risk of becoming disabled, regardless of the disorder causing the incapacity. In particular, we find that smokers are exposed to an increased risk of entering disability due to a mental disorder. Although the literature has shown that the relation between smoking and mental health is complex, there is indeed evidence that smoking increases the risk of getting mental disorders (Cuijpers et al., 2007; West and Jarvis, 2005). The relation between smoking and disability due to severe conditions such as cancer and cardiovascular diseases is well-known from the medical literature.

There are no significant gender differences in the risk of entering disability due to physical impairments, but there are such differences with respect to the risk of becoming disabled due to mental problems and severe conditions though. Men face a significantly lower risk of entering disability than women in these two cases. The higher disability risk of women due to mental disorders is in line with evidence from the medical literature that women have a higher risk of getting mental disorders (WHO, 2000).[18]

Because of potential differences between men and women, we estimate the competing risks models for men only as a robustness check; see Table 6.7.[19] The aforementioned results remain valid, with two main exceptions. For men, playing sports does not significantly decrease the risk of becoming disabled due to a mental disorder. This seems in line with the result in Table 6.5 that only for women playing sports significantly decreases the risk of becoming disabled in general. Second, for men previously experienced mental health problems significantly increase the risk of becoming disabled due to severe conditions. It is worth noting here that the severe conditions of the men and women in our sample differ a lot. For women we frequently observe breast and ovarium cancer as severe conditions, while for men cardiovascular diseases prevail.[20] The relation between mental disorders and cardiovascular diseases is confirmed by the medical literature, where it has been shown that depression is a risk factor for the onset of a wide range of cardiovascular diseases; (e.g., Van der Kooy et al., 2007).

We re-estimate all competing risks models and include interaction terms between the lifestyle indicators and the measures for physical and mental health. The interaction between the indicators for overweight and initial mental health problems is the only interaction term that turns out significant in some of the competing risks specifications. This interaction term is significantly positive in the MPH model for entry into disability

[18] We do not find significant unobserved heterogeneity for self-employed entering disability due to a mental disorder; the estimated Heckman-Singer frailty distribution is degenerate. We establish unfavorable frailty (resulting in relatively slow recovery) for 98.7% of the policyholders that enter disability due to severe conditions.

[19] We do not have enough female self-employed in the sample to estimate the competing risks models for women only.

[20] Because we do not have enough observations per disease category, it is not possible to use the more detailed information about the specific disorder in the MPH model.

due to physical impairments and in the MPH model for entry into disability due to severe conditions. In the latter two models overweight and mental ill-health exacerbate each other's effect on the risk of becoming disabled. None of the interaction terms turns out significant in the competing risks models for men.

6.6 Transitions out of disability

This section uses MPH models to assess the impact of health and lifestyle factors on self-employed workers' transitions out of disability.

6.6.1 Full sample

We include the same covariates as in the incidence model, with three exceptions. First, the included cohort dummies now apply to the year in which the disability started. Second, we measure age at the moment of becoming disabled. Third, we account for the type of disorder causing the disability using the health information in the medical certificate that is supplied with each disability claim. In the MPH model we use the aggregated disease categories (1) mental disorders, (2) physical impairments (muscular-skeletal disorders, injuries and poisoning), (3) severe conditions (neoplasms, diseases of blood and blood-forming organs, circulatory disorders, endocrine and nervous diseases), (4) unknown diseases and (5) mild disorders (infectious, eye, ear, respiratory, digestive, skin and genitourinary diseases). The latter category is chosen as the benchmark category in the estimations. We confine the discussion here to the health and lifestyle related factors, type of disorder, gender, and age.[21] The first panel of Table 6.8 (captioned 'full sample') reports the relevant estimation results for a MPH model with a three mass-point Heckman-Singer frailty distribution applied to the entire set of disability durations.

Initial physical health does not have a significant impact on the speed of recovery. Having mental problems prior to buying income insurance slows down recovery by 21% though. This effect is significant at the 1% level. Physical ill-health thus has a much more substantial effect on the incidence rate than on the recovery rate, while the effect of mental ill-health on entry into and exit out of disability is of the same magnitude. Policyholders with overweight have a 7% lower recovery rate than those with a normal weight, but the p-value is slightly too large for this effect to be significant at the 10% level. Both smoking and playing sports do not have a significant effect on the recovery rate. Somewhat surprisingly, we find that drinking alcohol increases the recovery rate by 11%; an effect that is significant at the 10% level. It is well-known that moderate

[21] Complete estimation results are available upon request.

alcohol intake is associated with a decreased risk of cardiovascular disease (e.g., O'Keefe et al., 2007), yet it is difficult to use this result to explain faster recovery from disability. It seems more likely that drinkers are more healthy than non-drinkers. A possible explanation could be that many non-drinkers are former drinkers who have quitted for health reasons, explaining why they are less healthy and recover more slowly than people who still drink (Cook and Moore, 2000). These considerations illustrate that we should be cautious in interpreting our results as causal effects. Despite our efforts to control for unobserved heterogeneity and selection effects with respect to the properties of the insurance contract, it is possible that we have not fully controlled for factors that affect both lifestyle (or health) and disability. In such a scenario the estimated effects would reflect correlations instead of causal relations.

Relative to mild diseases (the benchmark category), mental disorders have a 84% lower recovery rate (which is significant at each reasonable significance level). For severe conditions this percentage equals 64%. The negative effects of muscular-skeletal disorders and injuries on the recovery rate are also significant, but of a lesser magnitude (42% and 25%, respectively). The recovery rate of unknown diseases does not significantly differ from the benchmark category. The significantly negative effect of mental disorders on self-employed workers' recovery rate is in line with the results of Spierdijk et al. (2009) and Spierdijk and Koning (2014) and also coincides with what has been found for employees (e.g., Duijts et al., 2007; Koopmans et al., 2011; Knudsen et al., 2013).

The recovery rate of men is 16% higher than that of women, with significance at the 5% level. As mentioned before, the significant gender effect may be caused by differences between men and women in living conditions, lifestyle, education, family situation, social network, violence, and total (paid and unpaid) workload (Alexanderson et al., 1996). Spierdijk and Koning (2014) find that self-employed men recover faster than women, while Spierdijk et al. (2009) do not establish any significant gender differences in the speed of recovery. This diversity in results suggests that the effect of gender on recovery from disability can be very sample specific, which could be related to the fact that both their and our sample contains relatively few female self-employed. The effect of age on the recovery rate is significant and described by a concave and decreasing function.

Unobserved heterogeneity is captured by a three-point Heckman-Singer frailty distribution, which divides the sample into self-employed with favorable, medium favorable and unfavorable unobserved risk factors (64%, 21%, and 15% of the policyholders, respectively). Estimation of the same MPH model without frailty reveals a considerably lower log-likelihood value, illustrating the importance of accounting for frailty. The important role for unobserved heterogeneity in explaining the cross-sectional variation

in recovery rates is in line with the findings of Markussen et al. (2011) (employees) and Spierdijk and Koning (2014) (self-employed).

In line with Spierdijk and Koning (2014), we establish increasing duration dependence. This indicates that the recovery rate increases with the time elapsed since the start of the disability.

6.6.2 Subgroup estimations: good vs. bad lifestyle habits

To test whether certain bad lifestyle habits exacerbate the impact of other bad lifestyle habits and initial health on recovery from disability, we estimate the MPH model separately for the following subgroups of workers: (1) policyholders who have never smoked and those who currently smoke or smoked in the past; (2) overweight and normal-weight policyholders; (3) policyholders who drink and those don't; (4) policyholders who play sports and those who don't. As before, estimating separate MPH models for different subgroups allows for group-specific unobserved heterogeneity and additionally permits the observed risk factors to impact differently on the recovery rates of these groups.

The subgroup estimations reveal that being a current or past smoker is the only lifestyle factor that exacerbates the relation between health, lifestyle and recovery. The estimation results for smokers and non-smokers are in shown Table 6.9. Physical and mental ill-health significantly slow down smokers' recovery. For non-smokers, however, neither physical health nor mental health significantly affect the recovery rate. The relation between smoking and (both mental and physical) ill-health is well-known from the literature and now also turns out to affect recovery from disability.

Two other findings emerge from Table 6.9. For smokers drinking alcohol has a positive impact on the recovery rate (similar to what we found for the full sample), while its effect is insignificant for non-smokers. Furthermore, overweight significantly slows down smokers' recovery rate, while overweight turns out insignificant for non-smokers. The medical literature has already shown that the combination of smoking and overweight involves considerable health risks (Akbartabartoori et al., 2006). Our results point out that the combination of these two bad lifestyle habits has substantial adverse effects on recovery from disability.

The insignificance of initial mental health in the model for non-smokers in combination with the significance of the mental health measure for smokers suggests that the significance of initial mental health in the overall model of Section 6.6.1 is driven by the current and past smokers among the policyholders. Similarly, the estimation results suggest that the (almost) significance of overweight in the overall model of Section 6.6.1 is due to the current and past smokers among the policyholders. These results emphasize once more the importance of our subgroup analysis.

6.6.3 Subgroup estimations: gender, generosity of the insurance contract, occupational class

Bearing in mind the possibility of selection on the basis of unobserved risk factors, we apply a subsample analysis to assess the robustness of our results. We focus on the following populations: men, policyholders with full coverage, self-employed with a 1-month deferment period, and policyholders with a technical or industrial profession. The estimation results are displayed in Tables 6.8 (panels 2 – 5). We observe several differences in comparison with the full sample as displayed in the first panel of Tables 6.8. Men with overweight have a 10% lower recovery rate than men with a normal weight. The p-value of this effect is 0.03. In the full-sample model the p-value of the overweight coefficient just exceeds 0.10. Drinking alcohol does not have a significant effect on the recovery rate of men, while it significantly increases the recovery rate for the full-sample. Drinking alcohol does not have a significant effect on the recovery rate of claimants with full coverage, but we notice that the p-value only slightly exceeds 0.10. Drinking alcohol and being male does not significantly influence the recovery rate of self-employed with a 1-month deferment period. For policyholders in technical and industrial professions (which are virtually all men) drinking alcohol does not have a significant effect on the recovery rate, while being overweight slows down their hazard rate by 19% (with significance at the 1% level). Given the differences across subsamples, there might have been some selection on the basis of unobserved risk factors. Yet the effects of physical and mental ill-health, overweight, female gender and the type of disorder are fairly robust across different subsamples.

We re-estimate all MPH models for the recovery rate and allow for interaction between the lifestyle indicators and the measures for physical and mental health. However, these interaction terms do not turn out significant. As in Section 6.6.2, we find significant interaction between the indicators for current/past smoking and overweight in all previously estimated MPH models for the recovery rate. The resulting MPH model allows smoking and overweight to exacerbate each other's effect on the recovery rate. In all models the mental health measure continues to be significant in the presence of the interaction term, while the indicator for overweight loses its significance. This result suggests that the significance of overweight in the previously estimated subgroup models is due to the current and past smokers among the policyholders. The combination of smoking and overweight has considerable adverse effects on recovery from disability, which extends the finding in the medical literature that the combination of smoking and overweight involves substantial health risks (Akbartabartoori et al., 2006).

6.7 Conclusions

Because of the important economic role of insurance companies offering income insurance to self-employed, this case study has analyzed self-employed workers' disability outcomes from an insurance perspective.

Using the income insurance portfolio of the largest Dutch insurance company, our mixed proportional hazards approach has revealed that physical ill-health, mental ill-health and bad lifestyle habits generally have adverse effects on the disability outcomes of self-employed workers with income insurance. Yet the main result of our study is that accurate assessment of the relation between health, lifestyle and disability outcomes requires a subgroup analysis that distinguishes several groups of policyholders, such as smokers and non-smokers, overweight and normal-weight self-employed, and men and women. The subgroup analysis is crucial because important differences between subgroups tend to vanish in an aggregate analysis.

More specifically, we have shown that the impact of mental ill-health and smoking on the risk of becoming disabled is exacerbated by overweight, while the effects of physical ill-health, mental ill-health and overweight on recovery from disability are exacerbated by current and past smoking. We have also established significant differences between male and female self-employed. Men and women differ in the way smoking and playing sports affect their risk of becoming disabled. Furthermore, they also differ in the way mental ill-health affects their risk of becoming disabled due to a mental disorder or severe conditions such as cancer. The results continue to hold after correction for other risk factors and possible selection effects with respect to the properties of the insurance contract. Furthermore, the effects of health and lifestyle habits are both statistically significant and economically relevant.

Our findings can contribute to more effective criteria for risk selection and underwriting, the development of risk-based insurance premiums for income insurance, prevention of disability among self-employed, and optimization of their return-to-work process.

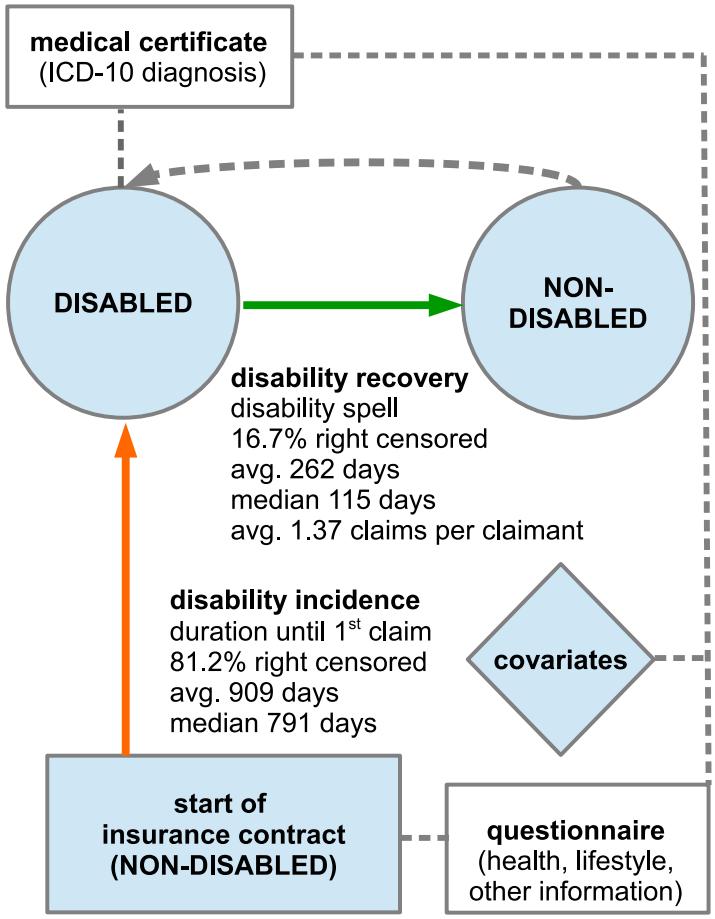
We would like to emphasize that some caution is required in interpreting our estimates as purely causal effects. Despite our efforts to control for unobserved heterogeneity and selection effects with respect to the properties of the insurance contract, it is possible that we have not fully controlled for factors that affect both lifestyle (or health) and disability. In such a scenario the estimated effects would reflect correlations instead of causal relations.

There are several directions for future research. We hope that the impact of health and lifestyle factors on self-employed workers' disability transitions will be explored in more detail using alternative data sources. Furthermore, several important questions remain to be answered. For example, are programs to prevent disability or to

improve occupational health and also effective for self-employed when they were actually designed for employees? We leave such questions as an important topic for future research.

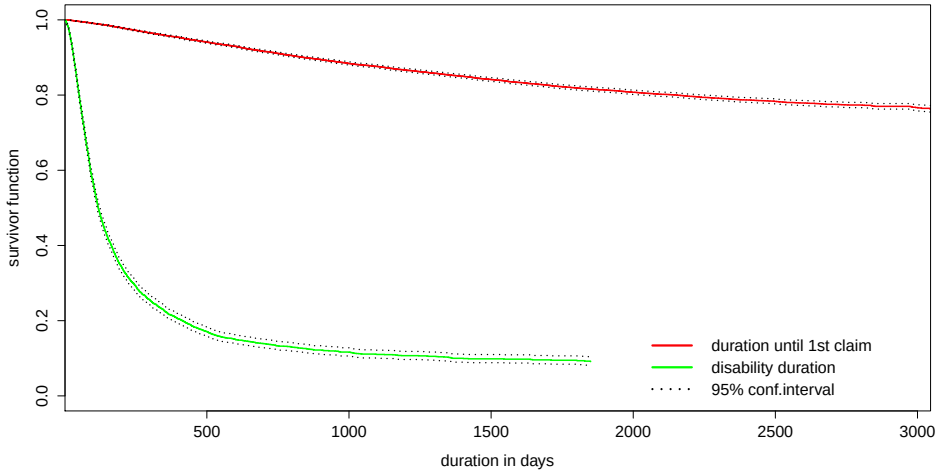
6.8 Tables and figures

Figure 6.1: Visual representation of the data



Notes: This diagram visualizes the data and its collection process. We distinguish three states: the start of the insurance contract, disabled and non-disabled. Upon buying income insurance self-employed complete the aforementioned questionnaire, which provides the covariates for modeling the incidence rate. At the start of the insurance contract the self-employed is, per definition, non-disabled. If self-employed become unable to work due to illness, they enter the state 'disabled'. In this case their health-status is updated with additional information about the ICD-10 diagnosis causing the disability. If a self-employed does not file a claim during the sample period, her duration until the first claim is right-censored. As soon as self-employed are able to resume work, they move to the state 'non-disabled'. If the sample period ends before a self-employed completes her disability spell, the resulting disability duration is marked as right-censored. Self-employed can file multiple disability spells during the sample period.

Figure 6.2: Kaplan-Meier estimates for duration until first claim and disability



Notes: This figure shows Kaplan-Meier estimates of the unconditional survivor functions corresponding with the durations until the first claim (upper curve) and the disability durations (lower curve).

Table 6.1: Questionnaire: current health, previously experienced health problems and lifestyle factors

Current health status		**claim**	**no claim**	**all**
curr.compl	current complaints	11.0	9.8	10.0
curr.disabled	being disabled	0.3	0.1	0.2
curr.complaints	complaints of any sort	4.3	3.9	4.0
curr.medication	on mediation	7.0	7.0	7.0
curr.infirmities	infirmities	1.1	0.6	0.7
curr.diet	being on a diet	0.9	0.7	0.7
Experienced health problems				
complaint.psy	mental disorders	12.3	10.8	11.0
complaint.trop	tropical diseases	0.6	0.4	0.4
complaint.std	sexually transmitted diseases	1.3	1.4	1.4
complaint.ent	ear, nose and throat problems	17.3	15.6	15.9
complaint.lung	respiratory disorders	11.0	10.9	10.9
complaint.heart	heart/blood vessel problems	6.8	6.1	6.2
complaint.hormone	diabetes and high cholesterol	4.3	4.0	4.1
complaint.stomach	stomach problems	10.3	9.2	9.4
complaint.uri	urinal inf. and genitourinary dis.	7.4	7.1	7.2
complaint.joints	physical problems (limbs, joints)	54.2	47.3	48.6
complaint.ans	arm, neck or shoulder complaints	17.9	14.2	14.9
complaint.back	back problems	21.4	18.9	19.4
complaint.head	headaches, dizziness, faints	5.2	4.7	4.8
complaint.blood	anaemia, haemophilia	4.5	4.1	4.2
complaint.sleep	sleeping, appetite and defecation	1.8	1.6	1.6
complaint.derm	skin problems	26.7	28.5	28.2
complaint.rest	any other complaints	19.2	16.8	17.2
Lifestyle factors				
length	length (in centimeters)	181.0	181.0	181.3
weight	weight (in kilograms)	80.0	81.0	80.5
smoker	current smoker	23.8	19.5	20.3
smoked	former smoker	23.9	24.1	24.0
sports	play sports	85.9	87.1	86.9
alcohol	drink alcoholic beverages	65.0	69.4	68.6
overweight	overweight	39.7	38.5	38.8
obese	obese	3.3	3.2	3.2

Notes: This table describes the explanatory variables related to policyholders' current and previously experienced health problems, as well as their life style habits. This information is obtained from the questionnaire that they fill in upon buying income insurance. The figures in the columns captioned 'claim', 'no claim' and 'all' are sample means (in % for the indicator variables) calculated over the policyholders who filed a claim, who did not file a claim and all policyholders, respectively.

Table 6.2: Explanatory variables: sociodemographic status, occupational class, insurance contract and type of disorder

Sociodemographic factors		**claim**	**no claim**	**all**
age	age (in years)	35.1	34.8	34.8
male	males	83.0	85.3	84.8
Occupational class				
o.agricultural	agricultural sector	15.1	13.0	13.4
o.commercial	commercial and administrative	14.5	29.9	27.0
o.technical	technical and industrial	42.1	28.5	31.0
o.medical	medical and paramedical	12.5	9.9	10.4
o.retail	retail or wholesale	8.7	10.8	10.4
o.services	services and care sector	5.6	6.1	6.0
o.transport	transport sector	1.6	1.8	1.7
Insurance contract				
repl.income	annual replacement income (EUR)	32,993	34,285	34,042
lim.cov	limited coverage	24.9	20.4	21.3
defer.15	deferment period of 15 days	15.3	7.9	9.3
defer.30	deferment period of 1 month	57.8	48.3	50.2
defer.60	deferment period of 2 months	7.2	8.5	8.2
defer.90	deferment period of 3 months	12.3	18.9	17.6
defer.1	deferment period of 1 year	3.7	8.0	7.2
defer.23	deferment period of 2 or 3 years	3.7	8.4	7.5
Type of ICD-10 disorder				
diag.infectious	infectious and parasitic diseases	1.3		
diag.neoplasms	neoplasms	1.6		
diag.blood	diseases of the blood(-forming organs)	0.6		
diag.endocrine	endocrine diseases	0.9		
diag.mental	mental disorders	12.1		
diag.nervous	diseases of the nervous system	2.6		
diag.eye	diseases of the eyes	0.8		
diag.ear	diseases of the ears	0.3		
diag.circular	diseases of the circular system	3.3		
diag.respiratory	respiratory disorders	3.6		
diag.digestive	digestive diseases	4.5		
diag.skin	diseases related to the skin	1.5		
diag.musculoskeletal	diseases of the musculoskeletal system	37.6		
diag.genitourinary	genitourinary diseases	2.4		
diag.injury	injuries and poisoning	20.6		
diag.unknown	unknown diseases	6.2		

Notes: This table provides descriptions of several groups of explanatory variables that find their origin in the questionnaire completed by the self-employed upon buying income insurance. The covariates relate to policyholders' socio-demographic status, their occupational class, the properties of their insurance contract and (in case of a claim) their ICD-10 diagnosis. The figures in the columns captioned 'claim', 'no claim' and 'all' are sample means (in % for the indicator variables) calculated over the policyholders who filed a claim, who did not file a claim and all policyholders, respectively.

Table 6.3: Transitions into disability: all disorders and competing causes of disability

	all disorders			*mental disorders*			*physical impairments*			*severe conditions*		
	exp (β_D)	**stdev**	***p*-value**	**exp (β_C^1)**	**stdev**	***p*-value**	**exp (β_C^2)**	**stdev**	***p*-value**	**exp (β_C^3)**	**stdev**	***p*-value**
health.index	1.0049	0.0008	0.0000	1.0034	0.0017	0.0490	1.0040	0.0011	0.0002	1.0060	0.0027	0.0260
complaint.psy	1.2609	0.0718	0.0012	1.7379	0.1227	0.0000	0.9977	0.0970	0.9810	1.3063	0.2122	0.2078
overweight	0.9905	0.0474	0.8412	0.9531	0.1010	0.6348	1.0004	0.0598	0.9942	1.2037	0.1496	0.2153
smoker	1.2209	0.0578	0.0006	1.4220	0.1161	0.0024	1.1375	0.0727	0.0766	1.7403	0.1828	0.0024
smoked	0.9966	0.0557	0.9510	0.9596	0.1207	0.7327	1.0236	0.0702	0.7398	1.0663	0.1780	0.7182
sports	1.0351	0.0492	0.4826	0.8270	0.1047	0.0696	1.1465	0.0613	0.0258	0.9438	0.1627	0.7224
alcohol	0.9326	0.0661	0.2908	0.8913	0.1339	0.3899	1.0278	0.0850	0.7471	0.8189	0.2041	0.3275
male	0.6380	0.0718	0.0000	0.5163	0.1218	0.0000	0.9276	0.0951	0.4293	0.3497	0.2276	0.0000
age	0.9340	0.0187	0.0003	0.9766	0.0410	0.5627	0.9336	0.0238	0.0039	0.9722	0.0613	0.6458
age^2	1.0013	0.0003	0.0000	1.0006	0.0005	0.2647	1.0012	0.0003	0.0004	1.0015	0.0008	0.0696
	estim	**stdev**	***p*-value**	**estim**	**stdev**	***p*-value**	**estim**	**stdev**	***p*-value**	**estim**	**stdev**	***p*-value**
u_1	-6.3447	0.6185	0.0000	-15.4923	1.2162	0.0000	-6.0476	0.8139	0.0000	-12.7905	1.9625	0.0000
u_2	-3.4611	0.6103	0.0000				-2.8609	0.7845	0.0003	-7.7581	1.8943	0.0000
p	0.8420	0.0172	0.0000				0.8337	0.0395	0.0000	0.9874	0.0050	0.0000
γ	1.1751	0.0855	0.0000	1.0881	0.1461	0.0000	1.0966	0.1004	0.0000	1.1779	0.3107	0.0000
logL	-21,276.5			-3,558.3			-13,582.4			-2,743.9		
# obs.	20,469			20,469			20,469			20,469		

Notes: This table displays the estimation results for several MPH specifications of the incidence rate, including a competing risks approach. All models include additional control variables not listed in the table (occupational class, characteristics of the insurance contract, and cohort effects). The columns captioned 'exp(β_D)' and 'exp(β_C^m)' provide hazard ratios, for $m = 1, 2, 3$. As usual, the standard deviations and p-values correspond with β_D and β_C^m. The discrete Heckman-Singer frailty distribution is specified as $\mathbb{P}(u = u_1) = 1 - \mathbb{P}(u = u_2) = p$. The parameter γ is the shape parameter of the Weibull baseline distribution.

Table 6.4: Transitions into disability: normal weight vs. overweight

	normal weight			*overweight*		
	exp (β_D)	**stdev**	***p*-value**	**exp (β_D)**	**stdev**	***p*-value**
health.index	1.0064	0.0011	0.0000	1.0029	0.0013	0.0219
complaint.psy	1.1142	0.0971	0.2654	1.4882	0.1082	0.0002
smoker	1.1321	0.0762	0.1034	1.3702	0.0894	0.0004
smoked	1.0050	0.0752	0.9474	1.0010	0.0829	0.9909
sports	1.0837	0.0651	0.2173	0.9637	0.0752	0.6229
alcohol	0.8934	0.0861	0.1905	1.0153	0.1036	0.8836
male	0.6641	0.0860	0.0000	0.5594	0.1366	0.0000
age	0.9306	0.0238	0.0025	0.9268	0.0320	0.0176
age^2	1.0014	0.0003	0.0000	1.0013	0.0004	0.0019
	estim	**stdev**	***p*-value**	**estim**	**stdev**	***p*-value**
v_1	-6.7181	0.7885	0.0000	-5.4878	1.0200	0.0000
v_2	-3.7530	0.7749	0.0000	-2.7872	1.0162	0.0061
p	0.8393	0.0199	0.0000	0.8246	0.0389	0.0000
γ	1.1638	0.1075	0.0000	1.1851	0.0415	0.0000
logL	-12,867.7			-8,388.2		
# obs.	12,563			7,906		

Notes: This table displays the estimation results for MPH specifications of the incidence rates of two groups of policyholders: normal-weight and overweight self-employed. The models include additional control variables not listed in the table: occupational class (model for a 1-month deferment period only), characteristics of the insurance contract (including the indicator variables for the length of the deferment period in the model for technical/industrial professions), and cohort effects (both models). The columns captioned 'exp(β_D)' provide hazard ratios. As usual, the standard deviations and p-values correspond with β_D. The discrete Heckman-Singer frailty distribution is specified as $\mathbb{P}(v = v_1) = 1 - \mathbb{P}(v = v_2) = p$. The parameter γ is the shape parameter of the Weibull baseline distribution.

Table 6.5: Transitions into disability: men, women, full coverage and limited coverage

	men			*women*			*full coverage*			*limited coverage*		
	exp (β_D)	**stdev**	***p*-value**	**exp (β_D)**	**stdev**	***p*-value**	**exp (β_D)**	**stdev**	***p*-value**	**exp (β_D)**	**stdev**	***p*-value**
health.index	1.0048	0.0009	0.0000	1.0045	0.0019	0.0185	1.0051	0.0010	0.0000	1.0036	0.0018	0.0463
complaint.psy	1.2509	0.0839	0.0077	1.2986	0.1321	0.0480	1.3636	0.0939	0.0010	1.1433	0.1107	0.2263
overweight	0.9772	0.0514	0.6528	1.1255	0.1247	0.3429	1.0131	0.0558	0.8158	0.9570	0.0934	0.6380
smoker	1.2394	0.0630	0.0007	1.1014	0.1446	0.5042	1.2569	0.0679	0.0008	1.0952	0.1136	0.4237
smoked	0.9984	0.0617	0.9795	0.9750	0.1251	0.8393	0.9829	0.0658	0.7938	1.0594	0.1087	0.5953
sports	1.0819	0.0539	0.1441	0.7884	0.1216	0.0505	1.0354	0.0580	0.5481	1.0282	0.0974	0.7751
alcohol	0.9556	0.0784	0.5619	0.8484	0.1165	0.1584	0.9388	0.0781	0.4189	0.9356	0.1277	0.6021
male							0.6359	0.0860	0.0000	0.6050	0.1336	0.0002
age	0.9284	0.0207	0.0003	0.9660	0.0424	0.4153	0.9215	0.0214	0.0001	0.9534	0.0405	0.2385
age^2	1.0013	0.0003	0.0000	1.0011	0.0006	0.0681	1.0015	0.0003	0.0000	1.0011	0.0006	0.0518
	estim	**stdev**	***p*-value**	**estim**	**stdev**	***p*-value**	**estim**	**stdev**	***p*-value**	**estim**	**stdev**	***p*-value**
v_1	-6.7881	0.7262	0.0000	-7.3034	1.2639	0.0000	-5.8669	0.7154	0.0000	-8.0716	1.2977	0.0000
v_2	-3.8626	0.7172	0.0000	-4.8928	1.2265	0.0001	-2.8330	0.7094	0.0001	-5.1352	1.2404	0.0000
p	0.8434	0.0183	0.0000	0.7757	0.0949	0.0000	0.8624	0.0150	0.0000	0.6998	0.0659	0.0000
γ	1.1675	0.0923	0.0000	1.1796	0.2236	0.0000	1.1826	0.0993	0.0000	1.1960	0.0464	0.0000
logL	17,696.3			-3,553.5			-16,122.5			-5,138.0		
# obs.	17,325			3,144			16,112			4,357		

Notes: This table displays the estimation results for MPH specifications of the incidence rates of four groups of policyholders: men, women, with full coverage, and with limited coverage. All models include additional control variables not listed in the table (occupational class, characteristics of the insurance contract, and cohort effects). The columns captioned 'exp(β_D)' provide hazard ratios. As usual, the standard deviations and p-values correspond with β_D. The discrete Heckman-Singer frailty distribution is specified as $\mathbb{P}(v = v_1) = 1 - \mathbb{P}(v = v_2) = p$. The parameter γ is the shape parameter of the Weibull baseline distribution.

Table 6.6: Transitions into disability: 1-month deferment period and technical/industrial professions

	1-month deferment period			*technical/industrial professions*		
	exp (β_D)	**stdev**	**p-value**	**exp (β_D)**	**stdev**	**p-value**
health.index	1.0044	0.0012	0.0002	1.0037	0.0015	0.0119
complaint.psy	1.3484	0.0988	0.0025	1.3248	0.1301	0.0306
overweight	0.9487	0.0667	0.4300	0.9970	0.0797	0.9699
smoker	1.2626	0.0803	0.0037	1.2433	0.0921	0.0181
smoked	1.0314	0.0784	0.6934	0.9821	0.0955	0.8501
sports	1.0346	0.0691	0.6228	1.1363	0.0789	0.1051
alcohol	0.9656	0.0920	0.7035	0.9907	0.1200	0.9378
male	0.6750	0.0990	0.0001			
age	0.9523	0.0264	0.0643	0.9358	0.0343	0.0532
age^2	1.0010	0.0004	0.0046	1.0012	0.0005	0.0149
	estim	**stdev**	**p-value**	**estim**	**stdev**	**p-value**
v_1	-8.2625	0.8884	0.0000	-7.6391	1.2987	0.0000
v_2	-5.2172	0.8685	0.0000	-4.5761	1.2888	0.0004
p	0.8457	0.0173	0.0000	0.8078	0.0218	0.0000
γ	1.2339	0.1215	0.0000	1.2640	0.1317	0.0000
logL	-12,016.3			-8,559.2		
# obs.	10,267			6,467		

Notes: This table displays the estimation results for MPH specifications of the incidence rates of two groups of policyholders: with a 1-month deferment period and with a technical or industrial profession. Because there are virtually no female policyholders in technical and industrial professions, there is no gender dummy included in the MPH. The models include additional control variables not listed in the table: occupational class (model for a 1-month deferment period only), characteristics of the insurance contract (including the indicator variables for the length of the deferment period in the model for technical/industrial professions), and cohort effects (both models). The columns captioned 'exp(β_D)' provide hazard ratios. As usual, the standard deviations and p-values correspond with β_D. The discrete Heckman-Singer frailty distribution is specified as $\mathbb{P}(v = v_1) = 1 - \mathbb{P}(v = v_2) = p$. The parameter γ is the shape parameter of the Weibull baseline distribution.

Table 6.7: Transitions into disability: competing causes of disability (men only)

	mental disorders			*physical impairments*			*severe conditions*		
	exp (β_C^1)	**stdev**	***p*-value**	**exp** (β_C^2)	**stdev**	***p*-value**	**exp** (β_C^3)	**stdev**	***p*-value**
health.index	1.0050	0.0029	0.0836	1.0039	0.0011	0.0006	1.0069	0.0036	0.0544
complaint.psy	2.7311	0.2222	0.0000	0.9815	0.1081	0.8631	1.6782	0.2672	0.0526
overweight	0.8777	0.1661	0.4320	1.0011	0.0620	0.9863	1.2231	0.1880	0.2841
smoker	1.6128	0.1961	0.0148	1.1697	0.0761	0.0394	1.9232	0.2218	0.0032
smoked	0.9483	0.2034	0.7940	1.0816	0.0740	0.2891	0.9383	0.2350	0.7864
sports	0.8039	0.1776	0.2191	1.1691	0.0643	0.0151	0.9340	0.2139	0.7495
alcohol	0.8479	0.2474	0.5049	1.0510	0.0959	0.6040	0.9644	0.2989	0.9035
age	0.9996	0.0696	0.9953	0.9468	0.0254	0.0313	0.8901	0.0763	0.1270
age^2	1.0004	0.0009	0.6475	1.0009	0.0004	0.0076	1.0027	0.0010	0.0078
	estim	**stdev**	***p*-value**	**estim**	**stdev**	***p*-value**	**estim**	**stdev**	***p*-value**
u_1	-13.4839	2.3749	0.0000	-6.9115	0.9561	0.0000	-14.7709	2.4976	0.0000
u_2	-8.0746	2.3046	0.0005	-3.7294	0.8856	0.0000	-9.2258	2.4260	0.0001
p	0.9866	0.0037	0.0000	0.8117	0.0546	0.0000	0.9851	0.0040	0.0000
γ	1.4160	0.3624	0.0000	1.0801	0.1032	0.0000	1.2671	0.3376	0.0000
logL	-2,652.1			-11,887.9			-2,104.9		
# obs.	17,325			17,325			17,325		

Notes: This table displays the estimation results for the competing risks model of the incidence rate, applied to male policyholders only. All models include additional control variables not listed in the table (occupational class, characteristics of the insurance contract, and cohort effects). The columns captioned 'β_C^m' provide hazard ratios. As usual, the standard deviations and p-values correspond with β_C^m, for $m = 1, 2, 3$. The discrete Heckman-Singer frailty distribution is specified as $\mathbb{P}(u = u_1) = 1 - \mathbb{P}(u = u_2) = p$. The parameter γ is the shape parameter of the Weibull baseline distribution.

Table 6.8: Transitions out of disability: full sample, men, full coverage, 1-month deferment period and technical/industrial professions

	full sample			*men*			*full coverage*			*1-month deferment period*			*technical/industrial professions*		
	exp (β_R)	**stdev**	***p*-value**	**exp (β_R)**	**stdev**	***p*-value**	**exp (β_R)**	**stdev**	***p*-value**	**exp (β_R)**	**stdev**	***p*-value**	**exp (β_R)**	**stdev**	***p*-value**
health.index	0.9994	0.0008	0.4632	0.9995	0.0009	0.5624	0.9987	0.0009	0.1555	1.0002	0.0010	0.8214	1.0007	0.0012	0.5635
complaint.psy	0.7921	0.0684	0.0007	0.7685	0.0782	0.0008	0.8207	0.0929	0.0333	0.8185	0.0866	0.0206	0.6827	0.1035	0.0002
overweight	0.9293	0.0455	0.1073	0.8968	0.0490	0.0264	0.8820	0.0534	0.0188	0.8746	0.0581	0.0210	0.8136	0.0665	0.0019
smoker	0.9969	0.0548	0.9549	0.9999	0.0595	0.9985	1.0088	0.0641	0.8915	1.0404	0.0709	0.5762	1.0040	0.0759	0.9580
smoked	0.9584	0.0540	0.4310	0.9121	0.0591	0.1194	1.0102	0.0635	0.8725	1.0197	0.0687	0.7767	0.9578	0.0808	0.5936
sports	1.0174	0.0463	0.7092	1.0400	0.0506	0.4384	1.0289	0.0539	0.5973	0.9800	0.0590	0.7316	1.1008	0.0657	0.1438
alcohol	1.1142	0.0631	0.0864	1.0640	0.0728	0.3944	1.1283	0.0744	0.1048	1.0941	0.0841	0.2846	1.0397	0.0981	0.6914
male	1.1586	0.0716	0.0397				1.2354	0.0836	0.0114	1.0707	0.0947	0.4708			
age	0.9999	0.0176	0.9943	1.0119	0.0192	0.5380	1.0059	0.0202	0.7717	0.9890	0.0232	0.6351	1.0368	0.0277	0.1924
age^2	0.9998	0.0002	0.4055	0.9997	0.0002	0.1579	0.9997	0.0003	0.2588	1.0000	0.0003	0.9702	0.9993	0.0004	0.0620
diag.mental	0.2623	0.0804	0.0000	0.2614	0.0892	0.0000	0.2579	0.0947	0.0000	0.2614	0.1005	0.0000	0.5808	0.1018	0.0000
diag.musco	0.5793	0.0602	0.0000	0.5906	0.0658	0.0000	0.6231	0.0702	0.0000	0.5909	0.0773	0.0000	0.3486	0.1521	0.0000
diag.injury	0.7492	0.0682	0.0000	0.7447	0.0726	0.0000	0.7662	0.0806	0.0010	0.7670	0.0907	0.0034	1.6562	0.1316	0.0001
diag.severe	0.3612	0.0817	0.0000	0.3523	0.0919	0.0000	0.4012	0.0955	0.0000	0.4421	0.0985	0.0000	1.2443	0.1356	0.1071
diag.unknown	0.9935	0.0757	0.9313	1.0583	0.0843	0.5012	0.9666	0.0859	0.6926	0.7075	0.0970	0.0004	1.8867	0.1098	0.0000
	estim	**stdev**	***p*-value**	**estim**	**stdev**	***p*-value**	**estim**	**stdev**	***p*-value**	**estim**	**stdev**	***p*-value**	**estim**	**stdev**	***p*-value**
w_1	0.3914	0.6123	0.5227	1.7386	0.7225	0.0161	0.5703	0.7050	0.4186	1.0385	0.7962	0.1921	2.2470	1.1509	0.0509
w_2	-2.1710	0.6157	0.0004	0.5131	0.7242	0.4787	-2.0423	0.7071	0.0039	-2.6762	0.8049	0.0009	1.0321	1.1476	0.3685
w_3	1.6750	0.6103	0.0061	-2.2316	0.7272	0.0021	1.8400	0.7015	0.0087	-0.2398	0.8089	0.7669	-2.0174	1.1467	0.0785
p_1	0.3807	0.0259	0.0000		0.0001	0.0000		0.0299	0.0000	0.9288	0.0004	0.0000	0.9184	0.0001	0.0000
p_2	0.3455	0.0156	0.0000		0.0016	0.0000	0.3440	0.0177	0.0000	0.0481	0.0042	0.0000	0.0689	0.0021	0.0000
γ	1.2575	0.0509	0.0000	1.2795	0.0578	0.0000	1.2792	0.0620	0.0000	1.2684	0.0679	0.0000	1.3306	0.0842	0.0000
logL	-8,345.5			-6,840.8			-6,217.2			-4,792.4			-3,449.9		
# obs.	5,427			4,554			4,070			3,157			2,399		

Notes: This table displays the estimation results for MPH specifications of the recovery rates of five groups of claimants: all of them, men, with full coverage, with a 1-month deferment period, and with a technical or industrial profession. All models include additional control variables not listed in the table (occupational class, characteristics of the insurance contract, and cohort effects). The columns captioned 'exp(β_R)' provide hazard ratios. As usual, the standard deviations and p-values correspond with β_R. The discrete Heckman-Singer frailty distribution is specified as $\mathbb{P}(w = w_i) = p_i$. The parameter γ is the shape parameter of the Weibull baseline distribution.

Table 6.9: Transitions out of disability: non-smokers vs. smokers

	non-smokers			*smokers*		
	exp (β_R)	**stdev**	***p*-value**	**exp (β_R)**	**stdev**	***p*-value**
health.index	0.9990	0.0011	0.3262	0.9979	0.0012	0.0949
complaint.psy	0.8557	0.0958	0.1039	0.7699	0.0937	0.0053
overweight	0.9737	0.0595	0.6542	0.8930	0.0676	0.0941
sports	1.0134	0.0587	0.8206	1.0507	0.0690	0.4738
alcohol	1.0293	0.0778	0.7102	1.2681	0.1007	0.0183
male	1.2061	0.0875	0.0322	0.9829	0.1117	0.8776
age	0.9875	0.0233	0.5898	0.9795	0.0276	0.4520
age^2	1.0000	0.0003	0.9479	1.0000	0.0003	0.9895
diag.psych	0.2796	0.1076	0.0000	0.2491	0.1205	0.0000
diag.musco	0.5750	0.0760	0.0000	0.5627	0.0940	0.0000
diag.injury	0.8232	0.0872	0.0256	0.6873	0.1032	0.0003
diag.severe	0.3499	0.1026	0.0000	0.3872	0.1312	0.0000
diag.unknown	0.8943	0.1053	0.2885	1.2812	0.1174	0.0348
	estim	**stdev**	***p*-value**	**estim**	**stdev**	***p*-value**
w_1	-1.1667	0.8118	0.1507	1.7458	0.9988	0.0805
w_2	0.4669	0.7902	0.5546	2.9160	0.9966	0.0034
w_3	-3.5945	0.8248	0.0000	-0.9134	1.0005	0.3613
p_1	0.1476	0.0204	0.0000	0.2483	0.0253	0.0000
p_2	0.7407	0.0044	0.0000	0.5781	0.0097	0.0000
γ	1.2390	0.0672	0.0000	1.2756	0.0798	0.0000
logL	-4,327.4			-3,990.5		
# obs.	2,825			2,602		

Notes: This table displays the estimation results for MPH specifications of the recovery rates for smokers (defined as self-employed who currently smoke or smoked in the past) and non-smokers (self-employed who have never smoked). All models include additional control variables not listed in the table (occupational class, characteristics of the insurance contract, and cohort effects). The columns captioned 'exp(β_R)' provide hazard ratios. As usual, the standard deviations and p-values correspond with β_R. The discrete Heckman-Singer frailty distribution is specified as $\mathbb{P}(w = w_i) = p_i$. The parameter γ is the shape parameter of the Weibull baseline distribution.

6.9 Appendix

6.9.1 Likelihood functions

For completeness we provide the log-likelihood functions of all estimated MPH models. Throughout, we use the same notation as in Section 6.4.[22]

Incidence rate

Let

$$\lambda^D(t \mid X, v) = \lambda_0^D(t)\exp(X'\beta_D + v), \qquad S^D(t \mid X, v) = \exp\Big(-\int_0^t \lambda^D(s \mid X, v)ds\Big). \tag{6.4}$$

Now let D_k be the duration until the first claim of policyholder $k = 1, \ldots, n^D$, with vector of observed covariates X_k and unobserved heterogeneity v. We assume that v follows a discrete Heckman-Singer distribution with N^D mass points; i.e. $v \in \{v_1, \ldots, v_{N^D}\}$. Let $\delta_k^D = 0$ if D_k is right-censored. The joint likelihood function is obtained by integrating out the unobserved heterogeneity in the Lebesgue way, yielding

$$\log L = \sum_{k=1}^{n^D} \log\Big(\sum_{\ell=1}^{N^D} p_\ell S^D(D_k \mid X_k, v_\ell)\lambda^D(D_k \mid X_k, v_\ell)^{\delta_k^D}\Big), \tag{6.5}$$

where $p_\ell = \mathbb{P}(v = v_\ell)$ for $\ell = 1, \ldots, N^D$.

Recovery rate

Let

$$\lambda^R(t \mid Z, w) = \lambda_0^R(t)\exp(Z'\beta_R + w), \qquad S^R(t \mid Z, w) = \exp\Big(-\int_0^t \lambda^R(s \mid Z, w)ds\Big). \tag{6.6}$$

Zooming in on policyholders whole file at least one claim, let R_{jk} be the j-th disability spell of policyholder $k = 1, \ldots, n^R$, with vector of observed covariates Z_{jk} and unobserved heterogeneity w. We assume that w follows a discrete Heckman-Singer distribution with N^R mass points; i.e. $w \in \{w_1, \ldots, w_{N^R}\}$. Furthermore, we assume that policyholder k files a total of j_k disability spells and write $\delta_{jk}^R = 0$ if R_{jk} is right-censored.

[22] Throughout, all estimations have been done in R 3.0.2 using the maxLik package. The code is available upon request.

The joint log-likelihood function writes as

$$\log L = \sum_{k=1}^{n^R} \log\Big(\sum_{\ell=1}^{N^R} p_\ell \prod_{j=1}^{j_k} S^R(R_{jk} \mid Z_{jk}, w_\ell)\lambda^R(R_{jk} \mid Z_{jk}, w_\ell)^{\delta^R_{jk}}\Big), \tag{6.7}$$

where $p_\ell = \mathbb{P}(w = w_\ell)$ for $\ell = 1, \ldots, N^R$.

Competing risks

Let

$$\lambda^C_m(t \mid X, u) = \lambda^m_0(t)\exp(X'\beta^m_C + u), \qquad S^C_m(t \mid X, u) = \exp\Big(-\int_0^t \lambda^C_m(s \mid X, u)ds\Big). \tag{6.8}$$

Now let C_{km} be the duration until the first claim of policyholder $k = 1, \ldots, n^D$, resulting in a disorder of type m. Assume a vector of observed covariates X_k and unobserved heterogeneity u^m. Furthermore, we assume that u^m follows a discrete Heckman-Singer distribution with N^C_m mass points; i.e. $u^m \in \{u^m_1, \ldots, u^m_{N^C}\}$. Here $m = 1$ applies to mental disorders, $m = 2$ to physical impairments and $m = 3$ to severe conditions. Let $\delta^C_{km} = 1$ if the duration until the first claim of policyholder k leads to a disorder of type m and $\delta^C_{km} = 0$ in case of exit to another type of disorder or right censoring. The joint log-likelihood function of exits into disorders of type m writes as

$$\log L = \sum_{k=1}^{n^D} \log\Big(\sum_{\ell=1}^{N^C_m} p_{\ell m} S^C_m(C_{km} \mid X_k, u^m_\ell)\lambda^C_m(C_{km} \mid X_k, u^m_\ell)^{\delta^C_{km}}\Big), \tag{6.9}$$

where $p_{\ell m} = \mathbb{P}(u^m = u^m_\ell)$ for $\ell = 1, \ldots, N^C_m$.

6.9.2 Sanity check on latent measure for physical health

The estimated probit model is displayed in Table 6.10. Only the coefficients associated with tropical, sexually transmitted and urinal/genitourinary diseases turn out insignificant. The remaining coefficients have the expected positive sign.

To make sure that our latent physical health index has a clear economic interpretation, we investigate its Spearman partial rank correlation with the other risk factors more formally; see Table 6.11. Partial correlations are correlations that have been corrected for the influence of other covariates, like in a multiple regression. They reflect associations instead of causal relations, which avoids endogeneity issues. We relate the latent physical health measure to socio-demographic factors (age and gender), lifestyle

Table 6.10: Probit regression

	coef	**stdev**	z**-value**	p**-value**
intercept	-1.9853	0.0259	-76.6149	0.0000
complaint.trop	-0.2650	0.1935	-1.3694	0.1709
complaint.std	-0.1725	0.1088	-1.5852	0.1129
complaint.ent	0.1480	0.0327	4.5287	0.0000
complaint.lung	0.4617	0.0345	13.3950	0.0000
complaint.heart	0.9349	0.0395	23.6855	0.0000
complaint.hormone	1.1634	0.0467	24.9352	0.0000
complaint.stomach	0.3566	0.0378	9.4431	0.0000
complaint.uri	0.0646	0.0446	1.4476	0.1477
complaint.joints	0.1446	0.0257	5.6199	0.0000
complaint.ans	0.1057	0.0336	3.1416	0.0017
complaint.back	0.0683	0.0311	2.1935	0.0283
complaint.head	0.2911	0.0512	5.6874	0.0000
complaint.blood	0.4276	0.0513	8.3291	0.0000
complaint.sleep	0.4071	0.0802	5.0781	0.0000
complaint.derm	0.3860	0.0266	14.4956	0.0000
complaint.rest	0.3936	0.0301	13.0966	0.0000

Notes: This table displays the estimation results for the probit model used to predict the latent summary measure of initial physical health. The dependent variable in the probit model is the indicator for current health problems ('curr.compl') and the explanatory variables are the indicators for previously experienced health problems.

characteristics reported upon buying income insurance, occupational class, and the properties of the insurance contract (full/limited, the length of the deferment period and the level of the replacement income). As expected, we find that older policyholders tend to be less healthy. Males are on average in better health than females. Individuals with poor health are associated with limited coverage policies. The results also highlight notable differences in initial health across occupations and the level of replacement income. Surprisingly, playing sports is associated with poor health, which might be due to sports-related injuries like a fractured ankle (an issue that will come back in Section 6.5). As expected, current smoking, past smoking, and drinking alcohol are associated with poor health.

Table 6.11: Partial correlations

	part. cor.	***p*-value**
age	0.107	0.000
male	-0.057	0.000
smoker	0.024	0.001
smoked	0.058	0.000
alcohol	0.018	0.010
sports	0.035	0.000
overweight	0.031	0.000
o.commercial	0.091	0.000
o.technical	0.019	0.008
o.medical	0.051	0.000
o.retail	0.035	0.000
o.services	0.035	0.000
log(repl.income)	0.010	0.160
limited.coverage	0.206	0.000
defer.30	0.008	0.283
defer.60	0.011	0.100
defer.90	0.013	0.064
defer.1	0.003	0.630
defer.23	-0.001	0.899

Notes: This table displays the Spearman partial rank correlations between the latent measure of initial physical health and several covariates. The reported p-values correspond with the null hypothesis that the partial correlation is 0.

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Hoofdstuk 7

Summary in Dutch

Levenscyclusgedrag onder onzekerheid - Essays over besparingen, hypotheken en gezondheid.

De financiële crisis van 2007-2008 laat zien dat onzekerheid er toe doet. De sterke daling in aandelenprijzen en huizenprijzen, in combinatie met riskante hypotheekleningen, heeft een grote invloed op de financiële positie van huishoudens. Diverse bezuinigingsmaatregelen die zijn doorgevoerd hebben de komende jaren mogelijk verstrekkende financiële gevolgen. Het doel van dit proefschrift is te achterhalen in welke mate onzekerheid het financiële keuzegedrag van huishoudens beïnvloedt, zoals het spaargedrag en de aanschaf van financiële producten zoals een hypotheek. Wij zijn geïnteresseerd in verschillende bronnen van onzekerheid.

Op basis van een unieke enquête, laten wij zien dat de onzekerheid omtrent toekomstig beleid met betrekking tot een hervorming van de hypotheekrenteaftrek ervoor zorgt dat huishoudens meer gaan sparen om mogelijke financiële tegenvallers op te vangen. Deze extra besparingen door beleidsonzekerheid zijn weliswaar beperkt, maar brengen kosten met zich mee. Beleidshervormingen moeten daarom geloofwaardig zijn en eventuele additionele hervormingen moeten direct worden aangekondigd.

Wij onderzoeken vervolgens of een beperkte financiële kennis van complexe producten heeft geleid tot het afsluiten van riskante(re) hypotheekleningen. Wij tonen aan dat huishoudens over het algemeen goed bekend zijn met de risico's van de eigen hypotheeklening. Riskante hypotheken worden vaker afgesloten door huishoudens die meer verstand hebben van leningen en door huishoudens die gebruik maken van een hypotheekadviseur. Onzekerheid over de eigen financiële kennis leidt juist tot een meer gedegen keuze wat betreft het afsluiten van hypotheekleningen, tenzij er gebruik wordt gemaakt van een tussenpersoon. Dit benadrukt het belang van onafhankelijk financieel

advies.

Vervolgens onderzoeken wij de financiële positie van ouderen, die in het bijzonder door de hervormingen (in de ouderenzorg en pensioenen) worden getroffen. Hierbij maken wij gebruik van gedetailleerde belastinggegevens. Hieruit blijkt dat ouderen gemiddeld gezien vermogend zijn, maar hun spaargeld nauwelijks aanspreken, zelfs niet op een zeer hoge leeftijd (of in slechte gezondheid aan het einde van het leven). Deze bevinding is in tegenspraak met de economische levenscyclustheorie (indien mensen geen erfenismotief hebben) en kan niet worden verklaard door inkomensonzekerheid of onzekerheid over toekomstige gezondheidsuitgaven.

De gezondheidstoestand speelt wel een belangrijke rol om verschillen in besparingen tussen huishoudens te verklaren. Gepensioneerden met gezondheidsproblemen hebben gemiddeld gezien een lager (pensioen)vermogen opgebouwd. Er zijn aanwijzing dat het optreden van gezondheidsproblemen resulteert in meer besparingen, vermoedelijk omdat de consumptiebehoeften lager zijn dan vooraf voorzien. In het proefschrift bespreken wij een aantal beleidsopties om het gebruik van eigen vermogen voor bijvoorbeeld ouderenzorg te faciliteren en financiële middelen beter aan te laten sluiten bij de consumptiebehoeften van ouderen.

Om de samenhang tussen gezondheid en besparingen verder te onderzoeken ontwikkelen wij vervolgens een generieke gezondheidsmaatstaf op basis van door mensen zelf ervaren gezondheidstoestand en objectieve gezondheidskenmerken uit medische registers. Wij laten zien dat gezondheid meer persistent is en sneller afneemt op oudere leeftijd dan kan worden geconcludeerd op basis van enkel gerapporteerde gezondheid.

Tot slot onderzoeken wij de wisselwerking tussen de initiële mentale en fysieke gezondheid en levensstijl op het risico van arbeidsongeschiktheid. Hierbij maken wij gebruik van de gezondheidsverklaring die zelfstandigen invullen bij het afsluiten van een polis voor een arbeidsongeschiktheidsverzekering. Het is van belang om een onderscheid te maken tussen verschillende subgroepen in de populatie (zoals rokers en niet rokers, mensen met en zonder overgewicht, mannen en vrouwen). In het bijzonder mentale gezondheidsproblemen in combinatie met een ongezonde levensstijl (roken en overgewicht) vergroot het risico op langdurige arbeidsongeschiktheid. Deze uitkomst draagt bij aan een betere risicoselectie (dan wel het stimuleren van gezond gedrag) door verzekeraars. Dit is van belang voor de toegankelijkheid en betaalbaarheid van een particuliere inkomensverzekering.